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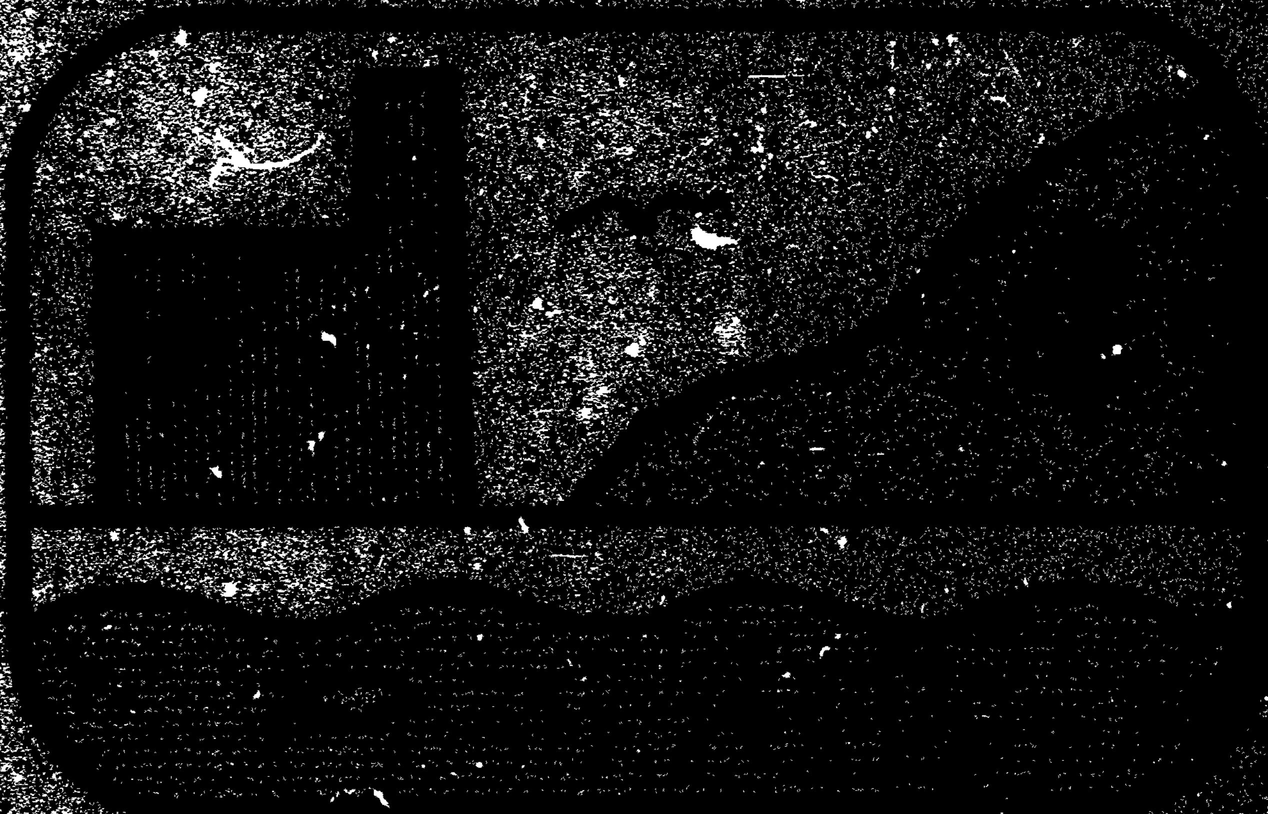
ABSTRACT

The detailed guide was prepared to help industrial arts personnel direct their students in a unit on environmental education, specifically geared for the industrial arts laboratory, which employs the Maryland Plan for implementing the unit method of instruction. Guidelines for implementing the program are based on experience with pilot projects and cover such topics as: the program's application to students of various ability levels (and of both sexes); suggested materials; interdisciplinary cooperation, especially with librarians, and speech and English teachers; team teaching; and suggested six-, eight-, and ten-week timetables for the presentation of the program, are given. Implementation suggestions include: sample handouts; formats and suggested procedures; a sample unit sequence; suggested lessons; and a list of subtopics and related projects. A 75-page section of the guide contains articles, advertisements, sketches, drawings, and technical illustrations of forms of pollution abatement equipment, as well as sketches of possible student projects. There are 37 pages of resources enumerating: local resource contact people; industries and businesses with answers to environmental problems; government agencies; State water pollution control agencies; publications; booklets and pamphlets; films and filmstrips; selected books; and aids and devices. A 10-page glossary of environmental terms is also included. (JR)

INDUSTRIAL ECOLOGY INSTRUCTIONAL GUIDE



FOR THE INDUSTRIAL ARTS TEACHER

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PREFACE/ACKNOWLEDGEMENTS

This INDUSTRIAL ECOLOGY INSTRUCTIONAL GUIDE for the Industrial Arts Teachers was developed by the student teachers participating in the Industria' Arts Ecology Pilot Program conducted at the State University College of New York at Oswego. During the implementation of six experimental "Industrial Ecology" units in selected public school pilot centers, the student teachers conducted a thorough evaluation of their efforts to identify and field test the specific role of industrial arts in environmental education.

During the final week of the pilot program, the student teachers spent five twelve-hour days in curriculum development designing, selecting, compiling, organizing and reproducing the materials in this Guide. Based on their experience with Industrial Ecology, they offer this Guide to the industrial arts teacher desiring to include environmental education in his program.

The participants and staff of the Industrial Arts Ecology Pilot Program acknowledge the cooperation of the participating public schools, the students, the cooperating industrial arts teacher/consultants and the respective school administrators. Recognition is also given to Andrea Calzone, secretary during the curriculum development phase of the program, for invaluable service and to Fred "Skip" Plank, Director of College Publications, for his assistance in preparing and running the offset plates. Special thanks is also extended to Dr. Darvey Carlsen and Mr. David Feux for the use of their graphic arts laboratories and equipment during the production of this Guide.

INDUSTRIAL ARTS ECOLOGY PILOT PROGRAM

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FALL, 1972

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DEFINITION OF TERMS

The following definitions are presented to clarify the meaning of important terms used throughout the INDUSTRIAL ECOLOGY INSTRUCTIONAL GUIDE.

1. ECOLOGY.......................... the study of man and his reciprocal relationship with his environment.

2. ENVIRONMENTAL EDUCATION........ an integrated process which deals with man's relationship with his natural and man-made surroundings, including the relation of population growth, pollution, resource allocation and depletion, conservation, technology, and urban and rural planning to the total human environment...
   Environmental Education Act

3. INDUSTRIAL ARTS.................... those phases of general education which in the public schools which deal with technology - its use and significance in contemporary society and with industry, its organization, materials, occupations, processes, and products-and with the problems and benefits resulting from the technological and industrial nature of present-day society.

4. INDUSTRIAL ECOLOGY.............. the study of man's reciprocal relationship with the industrial technological aspects of his environment, concentrating on the applications of technology to the solution of environmental problems. (See Ecology)

5. SUB-TOPIC......................... that part of the unit topic chosen by the individual student for independent research and study. (See Unit-Topic)

6. UNIT-TOPIC........................ the major area of study, which defines the scope of class activities in the Unit Method of instruction. (See Unit Method Section 2)

Middle, Campus Schools—

Industrial Ecology Pilot Program Introduced Here

An Industrial Arts Ecology Pilot Program is presently being conducted at both Oswego Middle School and Oswego Campus School.

At Oswego Middle School, Paul Meyer and James Leighton, student teachers at the State University College at Oswego, are conducting classes with fifty - two students in the 7th grade. They are working under the supervision of Frank Bartello, industrial arts teacher at the middle school.

Two classes of 7th and 8th graders are involved in the same program at the Oswego Campus School. Kenneth Andrus and Samuel Sher, student teachers also at S U C O, are working under the supervision of Mr Enso Nazzer, industrial arts teacher at the campus school.

Both teams are working under a special program, coordinated by Arthur Figurski, Assistant Professor Department of Industrial Arts and Technology, S. U. C. O.

The course will last for six weeks. It will be concerned with the industrial and technological contributions to the soluuon of environmental problems.

Students will be looking at what industrial technology is being applied to fight the pollution problem. They will choose an area of interest to them concerning these problems and will investigate their topic through consulting with industries, arranging field trips ad interviews, writing letters, personal contacts and many other available resources

Each student as a result of his research will be reporting his progress and findings to the class He will also apply his technical knowledge and skills using the industrial arts laboratory facilities to construct a project to represent his chosen technological approach to pollution abatement. Some students may choose to construct a miniature working model of an existing system being used or studied for full scale use in the environment.

In total, there are twelve student teachers from S U C O. presently field testing the Industrial Arts Pilot Program in the Oswego - Syracuse area The pilot program is expected to increase the students' awareness and sensitivity to environmental problems and to stimulate their investigation of possible solutions to these problems.

Students will also be gaining insights into possible occupations dealing with industrial technology and its role in our environment It is hoped that the results of the students' efforts can be placed on public display for the benefit of the entire community.

THE PALLADIUM-TIMES

Wed., Nov. 29, 1972

STUDENTS Holly Bridgers (right) and Julie Schmidt (left), at the Campus School, are making industrial contacts by phone to further explore their Industrial Ecology topics. Campus School and the Oswego Middle School are two of six schools in the Oswego-Syracuse area field testing the Industrial Arts Ecology program.

Liverpool, N. Y., Nov. 22, 1972

Mid schools, Oswego running pilot program

Two Liverpool middle schools are cooperating with SUNY at Oswego in a program to develop a team-teaching approach to ecology.

The experiment is known as the Industrial Arts Ecology Pilot Program, and will field test the relationship of industrial arts to the environment.

In cooperation with Arthur Figurski, a member of the Department of Industrial Arts and Technology at Oswego, the 12 IA majors in the program will be working independently as 2-man teams at five public schools located in the Syracuse-Oswego area. In Liverpool, the schools involved are Chestnut Hill Middle School and Liverpool Middle School.

Each team works with a cooperating consultant There are two teams and cooperating consultants at Chestnut Hill. They are Michael Aitner of Port Henry and Edward Bregande of Syracuse; George Boni, cooperating consultant; Edward Balaban of Little Neck and Richard McNamee of Jackson Heights; John Pauldine, cooperating consultant. At Liverpool Middle, the team members are William Johnson of Oswego and Philip O'Rourke of Lackawanna. John Kline is cooperating consultant.

Although the teams are working independently of each other, their approach to motivating seventh graders to investigate the various contributions of technology as solutions to environmental problems in practically identical Known as the unit approach, and developed at the University of Maryland School of Education a few years ago, this method incorporates four major phases. The first phase is one where the student is introduced to the main problem This main problem, or unit, for example, air pollution, is then divided into sub-topics, i.e., cars, smoke stacks, sulfur emissions, etc., that are chosen and individually researched by the student. The second phase consists of planning and designing a project that will directly relate (carburetor, scrubbers, filters) with the chosen sub-topic. Implementation of the aforementioned plans is the third phase. This would be the actual construction of the project Phase four is essentially a culminating activity, where the student presents and explains his project to the class and submits written evidence of his research A school display of individual work will be set up.

LIVERPOOL-SALINA-PHOENIX PENNYSAVER, NOVEMBER 29, 1972

INDUSTRIAL ARTS AT LIVERPOOL BLOWS ITS STACK

On Mon Oct. 30, twelve men, all industrial arts majors at the State University College at Oswego, N Y embarked on what might develop into one of the most fruitful educational journeys of late. These twelve student teachers, selected for their abilities and talents, will work at the junior high school level on developing a curriculum that incorporates a team teaching system The area in which this endeavor is concentrated on is ecology The experiment is known as the Industrial Arts Ecology Pilot Program, and will field test the relationship of industrial arts to the environment

In cooperation with Mr Arthur Figurski, a member of the Department of Industrial Arts and Technology at Oswego, the individuals in the LAEPP will be working independently as two-man teams at five public schools located in the Syracuse-Oswego area In Liverpool, the schools involved in this program are Chestnut Hill Middle School, Mr Roger Phillips, principal and Liverpool Middle School, Mr Richard DeFazio, principal

Each team works with a cooperating consultant There are two teams and cooperating consultants at Chestnut Hill. They are Michael Aitner of Port Henry N Y and Edward Bregande of Syracuse, Mr George Boni, cooperating consultant. Edward Balaban of Little Neck N Y and Richard McNamee of Jackson Heights, Mr John Pauldine, cooperating consultant At Liverpool Middle, the team members are William Johnson of Oswego and Philip O Rourke of Lackawana, Mr John Kline, cooperating consultant

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It is strongly hoped by all those who are involved in this undertaking that at the end of the six weeks given to actual field work, a greater awareness of technology s role in helping to solve the environmental problems it has helped to create will be fostered not only in the students of the LAEPP but in everyone who will have come into contact with the program itself

THE PALLADIUM-TIMES
Tues., Dec. 19, 1972

Ecology Project

Don Wallace at the Oswego Middle School operating the jig saw as he works on his Industrial Ecology project. Note: Safety glasses are always worn when working with industrial arts shop equipment. The Industrial Arts Ecology Pilot Program increases the students' awareness of environmental problems as each student independently investigates the ways industrial technology is trying to improve our environment. Don is building a project that will demonstrate a means of reducing industrial air pollution.

In Ecology Pilot Program

Catherine Cutler (left) and Dianne Wilbur (right), at the Campus School, are busy typing letters requesting information relating to their Industrial Ecology topics. They are participating in the Industrial Arts Ecology Pilot Program.

SECTION I

INTRODUCTORY MATERIALS

RATIONALE -- INDUSTRIAL ARTS & ENVIRONMENTAL EDUCATION

The widespread coverage given to the deterioration of our environment has served its purpose. People are finally becoming aware of the far reaching effects pollution is having on the ecological system. Essentially, a misunderstanding and lack of concern on the part of industry and society in general is the primary cause of the environmental problems that are plaguing our culture.

In order to increase the ecological awareness of those who will inherit this earth, the United States Office of Education has placed Environmental Education (EE) at the top of their priority list. Due to the fact that man's total interrelationships with both his natural and man-made environment must be considered, it is out of pure necessity that EE be multidisciplinary in nature.

Upon examination, it is obvious that a prime remedy to our environmental ills lies in the high technological level of our society. Industrial arts, whose goal it is to develop an understanding of the role of industry and technology in relation to man and his environment, holds a position in the educational framework to closely examine the industrial and technological aspects of pollution abatement.

Congressman John Brademas, author of the Environmental Education Act in the House, spells out the role of industrial arts in environmental education:

> The industrial arts, of course, is the discipline which has traditionally addressed man's relationship to the things he makes and uses, so it seems natural that men and women in the field should be leaders in the creation of some of these new educational forms. Both in creating new curricula for the classroom and in going out from the school to the community, people in industrial arts have an orientation to the real world which will make them invaluable in creating education for a new environment.
> (M/S/T, February, 1970)

In undertaking this new challenge, the Industrial Arts Ecology Pilot Program was developed at the State University of New York College of Arts and Sciences at Oswego. This instructional guide, based on the findings of the IAEPP participants, has been prepared to assist industrial arts personnel in achieving their part in the total EE program -- that of studying the technological aspects of environmental pollution and pollution control.

OBJECTIVES

Environmental Education has emerged as a national priority in our public schools. Every curriculum area irregardless of content structure is challenged to weave environmental concepts and activities into existing or modified programs as the campaign continues to produce a next generation with some degree of environmental awareness and sensitivity.

Because of industrial art's inherent ability to deal with the knowledge concerning industrial technology and its contributions to the solutions of environmental problems, it is recommended that industrial arts play a primary role in the total environmental education program in the schools concentrating on the industrial and technical aspects of this topic.

The INDUSTRIAL ECOLOGY INSTRUCTIONAL GUIDE, prepared during the culminating phase of the I.A.E.P.P., has been designed to assist the instructor in assuming his role in directing students in an environmental unit specifically geared for the industrial arts laboratory.

The following objectives have been established for this guide based on the information compiled during the field testing of the Industrial Arts Ecology Pilot Program.

1. To provide a rationale for implementation of environmental education in Industrial Arts.
2. To enable an instructor in Industrial Arts to implement a program in Industrial Ecology, using the unit method approach.
3. To suggest time allotment for the unit method.
4. To increase the instructor's awareness and sensitivity to environmental problems.
5. To provide the instructor with terms and knowledge of technical systems used in pollution abatement.
6. To discuss the application of team teaching and interdisciplinary cooperation using the unit approach.
7. To provide criteria for implementation of the program and student involvement.
8. To provide instructional materials to aid in the presentation of the unit.
9. To provide sample student projects, drawings, and reports compiled during the field testing phase of the pilot program.
10. To provide a list of sub-topics and projects compiled from the student activities during the field testing.
11. To provide a resource guide to books, magazines, personnel contacts, films, and other sources of information previously used by students and instructors.
12. To provide a glossary of terms for both instructor and student use.

EXPLANATION OF PILOT PROGRAM

For the past two and one half years, the professional field experience semester of the State University College at Oswego's Department of Industrial Arts and Technology has included the "Pilot Program" as an optional student teaching assignment. The pilot program was designed to enable teams of industrial arts student teachers to field test curriculum theories or approaches in the public school setting of selected pilot centers. The most often only "talked about" ways of teaching industrial arts are accomplished in the pilot centers by the student teachers with the assistance of the college supervisor and the cooperating consultant in the center.

The Industrial Arts Ecology program originated as a result of Oswego's Department of Industrial Arts and Technology's Staff Development Program, which was funded under the Education Professions Development Act. The "Environmental Edu.ation Resource Guide for Industrial Arts Teachers," was developed by Arthur Figurski as a result of the program. The resource guide proposes student study through research and project construction involving industrial pollution problems and control techniques as they relate to industrial technology. This resource guide became the "handbook" for implementation of the Industrial Arts Ecology Pilot Program.

During the spring 1972 semester in the pilot program, implemented at the senior high school level, industrial ecology was taught using subject-matter units. The environmental information was introduced to students as related information to the subject-matter units. As a result of this approach to industrial ecology, the student teachers involved in the pilot program, suggested that the program might better be implemented at the junior high school level. It was expressed that motivation was at a low level in the senior high. It was believed that the more active, more easily influenced junior high level students could be more effectively motivated to study the environmental pollution problems and technological solutions.

The IAEPP program was again implemented during the fall, 1972 semester. This semester, following the advice of the previously field tested pilot program, industrial education was tried at the junior high level. It followed the guidelines layed out in the Maryland Plan for implementation of the unit method of instruction.

It is thought now, because of the field testing at the junior high level, that senior high students could be successfully motivated using the unit method. Their level of knowledge, skills and level of maturity would prove valuable in this approach to education.

The objectives of the pilot program which was implemented on the junior high school level and which resulted in this writing are:

1. To field test the unit method, as used in the Maryland Plan, to implement a six week unit in industrial ecology.
2. To investigate the feasibility of implementing this unit in Industrial Ecology at the junior high or middle school level.

3. To produce, from each student teaching team, a slide show representative of each team's efforts in the centers. These are available on request.
4. To produce a curriculum guide for the implementation of an Industrial Ecology Unit based on the experience of the field testing results.

ORIENTATION TO THE UNIT METHOD

It was stated that one of the major objectives of IAEPP was to field test a program in Industrial Ecology using the Unit Method. The Unit Method or Unit Approach is not to be confused with the subject-matter unit. As most educators know, the subject unit concerns itself with the "subject matter, materials, and educative experiences built around a central subject matter area to be studied by pupils for the purpose of achieving learning outcomes that can be derived from experiences with subject matter" (Carter V. Good, Dictionary of Educational Terms). An example of a subject matter unit might be a unit in transportation.

The unit method design promotes social and educational development of pupils and motivates the incidential study of many different subjects necessary to the successful completion of the unit topic. For example, a unit method situation might be: under a Unit Topic, such as Transportation, students would select and research a Subtopic, such as the electric car, report on their findings and construct a project to represent their subtopic. Collectively, all the student projects will tell a story about the unit of transportation from which every student benefits.

As described in the Maryland Plan, "In the Unit Study (or Unit Method) each student selects an area (subtopic) that falls under the unit topic chosen by the class. (The water turbine is an example of a subtopic under the unit topic dealing with Power and Energy.) The students are involved in three areas of activities. They engage in the pursuit of information, project construction, and the sharing of information through the group seminar."

In the Industrial Ecology unit, students using the unit method, would be studying real life situations involving industrial technology relating to environmental problems. Application of their knowledge and skills in the industrial arts laboratory to these real situations provides increased meaning to the industrial arts subject area while giving the students insights and increased depth into the Industrial Technological relation to the environment.

The instructor's role in the unit method has changed from traditional, that of being a source of information, to that of guiding the student's development.

The "Maryland Plan" defines the teacher's role in implementing the Unit Method:

1. To assist students in the development of skills and techniques.
2. To stimulate students to establish higher personnal goals.
3. To promote a greater exercise of judgment and decision making on the part of the students.
4. To promote increased resourcefulness on the part of the students.
5. To provide the materials and apparatus necessary for the student to achieve his goal.
6. To instruct students in the use of the resources, apparatus and materials which will assist them in achieving their goals.

7. To emphasize the students' worthy accomplishments.
8. To guide students who need assistance in the solution of problems
9. To encourage student's creativity.
10. To assist students to recognize ways of refining their techniques of researching, constructing, communicating, analyzing, problem-solving, etc; and
11. To help students to evaluate their own efforts and achievements.

Essentially, the teacher should be a manager of education rather than the source of all information. A diagram of the Unit Method with explanations follows.

For FURTHER INFORMATION on this approach see "The Maryland Plan, Industrial Arts Program for the Junior High School," University of Maryland, Department of Industrial Education, College Park, Maryland. 1970

UNIT METHOD

INTRODUCTION ▼	- student is introduced to program and unit method
IDENTIFICATION OF MAJOR TOPICS ▼ SELECTION OF MAJOR UNIT TOPIC ▼	- the course in Industrial Ecology, elemented these steps by defining Industrial Ecology as the unit topic
IDENTIFICATION OF SUBTOPIC (environmental problems) ▼	- awareness and sensitivity of students is brought about by means of slides, films, periodicals, and brain storming. sessions.
SELECTION OF SUBTOPIC ▼	- From list of subtopics student selects one of interest to him.
INDIVIDUAL RESEARCH ▼	- Further investigation of subtopic.
IDENTIFICATION OF SOLUTIONS ▼	- solutions used to combat the problem identified in subtopic.
SELECTION OF SOLUTIONS ▼	- one of the solutions is developed into a project to demonstrate the solution.
PLANNING SUBTOPIC & PROJECT ▼	- Drawings, procedure sheets, and other planning is started.
CONSTRUCTING, CONSULTING, ADDITIONAL RESEARCH ▼	- research and construction may take place simultaneously.
SEMINARS ▼	- periodic seminars during the unit implementation allow students to share their progress with each other.
PRESENTATION OF PROJECT w/ DISPLAY ▼	- in the final seminar the fruits are shared, supporting materials are developed into display.
EVALUATION	- joint effort of students and instructor based on objectives of the unit.

SECTION 2

GUIDELINES FOR IMPLEMENTATION

GENERAL GUIDELINES FOR IMPLEMENTATION

At the time of the Industrial Arts Ecology Pilot Program the twelve student teacher participants, working in six team teaching situations, field tested the six week program in Industrial Ecology. The regular Industrial Arts program conducted by the cooperating industrial arts teacher (cooperating consultant) was modified to permit this six week experiment at each of the pilot centers. Each situation found seventh and eighth grade students at various stages of technical development, including some with no experience at all in the industrial arts laboratory.

Classes ranged in size from 13 to 22 students in the pilot centers. At three centers, the students were homogeneously grouped according to their abilities, students in the other centers were grouped heterogeneously.

Each industrial arts program in the six pilot centers was unique, depending on the instructors' personality and the needs of the entire school program. The industrial arts programs, operating in the pilot centers, normally expose the students to the laboratory facilities for as little as ten weeks and as long as a full semester.

The industrial arts facilities in the pilot centers were equipped either as a multi-field or general laboratory, some with emphasis on one material area more than others. The teacher in the field should note that the unit method is best implemented in the general laboratory setting with the gamut of equipment at hand. If one were in a single area situation, such as graphic arts, great difficulty would be encountered in implementing the Industrial Ecology Unit. The unit method depends on independent research and the utilization of a wide variety of resources and equipment.

Special Considerations For the Instructor

It has been suggested that a general laboratory facility is best for implementation of the Industrial Ecology Unit. In the event that the school does not have general laboratory facilities, but rather several specialized laboratories then the instructor is urged to make use of these other facilities when ever possible. In this situation, ideally, classes in each laboratory would be involved in the Industrial Ecology Unit and the open classroom technique could be utilized within the industrial arts department.

A list of commonly used materials in the pilot centers has been compiled to assist the instructor with preparing for the implementation of the Industrial Ecology Unit. (see Section 2: C)

It is recommended that the instructor meet with teachers in other subject areas to promote interdisciplinary cooperation. The approach to interdisciplinary cooperation as well as the team teaching approach, both recommended if possible, are discussed in detail in this section. (see Section 2: D, E, F & G)

Recognizing that different school systems deal with the implementation of industrial arts in different ways, as in the time alloted during the school year to industrial arts and the number of days per week etc., this Guide includes an outline of the Industrial Ecology Unit as it was implemented in the pilot centers as well as two alternative time schedules. These are discussed in Section 2: H, I, J & K.

The instructor will have the responsibility of adopting this program to his particular situation. The experienced teacher may use a good deal of latitude in any one of the suggested time tables with a good deal of success. It is the concensus from the results of the pilot program that the Unit best be implemented during the final portion of a comprehensive course in industrial arts.

Ideally it would be advantageous for the students to have had instruction in the subject units suggested by the New York State Education Department found in "The Early Secondary Instructional Guide," before the Industrial Ecology Unit is implemented. These units are commonly known as ceramics, electricity, graphic arts, metals, plastics, power mechanics and wood.

In the event that the students have had no previous exposure to industrial arts, allocation of time for basic conceptual lessons has been proposed on the graphs, section 2: I, J & K. Suggested lessons for this purpose can be found in Section 3 of this Guide.

As an after thought to the field testing of the Industrial Ecology Unit, the possibility of implementing the unit in the form of a mini-course or another form of special program has been discussed. The industrial arts teacher, by combining his ingenuity with the information in this Guide, could prepare an excellent program in such as situation as an adult education program.

Consideration of student participation in the Industrial Ecology Unit caused a great deal of controversy during the development of this guide. Even after compiling data from the field testing, some major disagreements arose concerning the ability of the Industrial Ecology Unit to foster significant learner outcome in students at different ability levels. The major question seems to be, "Can the Industrial Ecology Unit deal successfully with students on all levels of the ability spectrum and can it deal with all students in both the heterogeneous and the homogeneous situation?"

The only way this question can be satisfactorially answered is through the instructors' own "field testing" this program in his own situation using the information provided in this Guide and especially his experience in teaching. In this light the instructor should view the student considerations that follow, as things to watch for in his own program.

Dealing first with the slow learners, at one extreme it is felt that project oriented activities, such as the building of a tool box or bird house, provides the immediate motivation and reinforcement the slower learner's needs. It is also felt that the research and reports, etc., common to the Industrial Ecology Unit is of little use to the slow learner who's future place in society will never demand these skills from him.

The other extreme argues, that although the slow learner cannot compete with the average and advanced learner's communication skills, the individual instructional nature of the Unit Method allow the slow learner to strive for success on his own level of ability.

The instructor should note here that industrial arts especially at this level, is concerned with the general education of each student. Although tracking systems are unwisely used by guidance as early as the junior high level, it could be a grave mistake for teachers to "pigeon hole" a student at this age, hence, depriving him of many of the experiences shared by average students.

The wide variety of activities available to students through the Industrial Ecology Unit, such as business replys mailed to the student, contacts with industrial personnel and trips to industry where he may someday work, can all be valuable experiences for a student at any ability level. One such experience, quite different from many classroom activities, may be enough to develop an undiscovered talent in a slow student.

Some of the student teachers involved in the pilot program noted a high degree of motivation in the lower ability students. The potential here could be effectively guided by the experienced teacher to promote reasonable success.

The average student, in the Industrial Ecology Unit, can be expected to accept the tasks of the Unit Method as well as he would in most other classes. However, in addition to the enthusiasm generated by the active, manipulative nature of industrial arts, the Industrial Ecology Unit provides additional motivation for students with the use of many other activities, such as field trips and personal contacts that are not normally included in most school curriculums.

The above average student was found in some cases to be difficult to motivate during the initial stages of the Unit. Some had to be convinced that the program was truly going to offer freedom to determine their own course of action and independent development of the sub-topic. Once the program was under way, these students were able to exercise the new found freedom to carry out investigation and construction with a good deal of expertise.

A welcome addition to the industrial arts laboratory has been the introduction of girls to the industrial arts program during recent years. Although they sometimes pose special problems, it is recognized that the girls often take on tasks with a more mature attitude than boys of the same age. They also often take pride in doing a good job while many boys often make things simply for the excitement of doing something without being too concerned about quality. In the Industrial Ecology Unit, the girls have been found to accept the independent aspect of the research, such as writing business letters and making personal contacts by phone, with exceptional initiative. Written reports are another aspect which girls readily accept.

In one center it was particularily noted that girls are typically timid of the equipment, and in isolated cases, to the extent of outright fear of the unknown equipment. This trait can easily be overcome in most cases with encouragement from the teacher and good instruction. It was also noted that girls would ask for help when they were not sure of the equipment. In the same case a boy might attempt to do something, although incorrect, as to not admit his inexperience.

Essentially, all that has been said is characteristic of students in any situation. The minor inconsistencies occur because of the independent nature of the unit and introduction of many opportunities for new experiences for the students. The instructor will know better how to deal with these problems after he has "field tested" the program once in his own situation.

LABORATORY CONSIDERATIONS

The Unit Method of instruction, having the characteristics of independent research and individual instruction, can best be operated in a multi-field or general laboratory facility situation. The wood and metal facilities seem to be the natural basis for the construction of student projects, probably due to their common use in everything we come in contact with. With the aid of the instructor's expertise and insights, however, the student can be guided to the use of other material areas such as ceramics, drafting, electricity, graphic communications, polymers and power mechanics. These should be suggested when they can be efficiently utilized in the student's problem.

In support of interdisciplinary teaching, students should be encouraged to use any other available facility that can assist with his sub-topic completion. This is especially important in the event of a school having two or more industrial arts laboratories each consisting of unique facilities. (For example, Lab. A - wood, ceramics, graphic arts; Lab. B - metals, plastics, power mechanics.)

It may be noted, also, that the unit method by nature introduces increased usage of equipment and drain on supplies. Storage of projects was found to be a particular problem in a number of pilot program centers due to the size and nature of the projects.

It may be important to note here that in order to develop a certain level of technical and psycho-motor skills in the student, the student should utilize materials, tools and processes available in the industrial arts laboratory that are unique to industrial arts. Materials and construction techniques common to arts and crafts should not represent the sole or major portion of the construction of a student project. It is not the intention of the industrial ecology unit to substitute existing subject material in industrial arts, rather it is the intention to stimulate and reinforce these competencies that we have been traditionally teaching students.

SUGGESTED MATERIALS

The following is a list of materials that were commonly used during the implementation of the Industrial Arts Ecology Pilot Program. We suggest that an instructor acquire, if possible, or have the following materials readily available before becoming involved in the construction phase of the program.

1.	Tin plate	20-26 gauge
2.	Galvanized steel	20-26 gauge
3.	Aluminum sheet	20-28 gauge
4.	Plywood	1/4" - 3/4"
5.	Pine	1/4" - 3/4"
6.	Masonite	1/4" - 3/8"
7.	Sheathing	1/2" - 3/4"
8.	Tin cans	3" D. - 55 gal. drum
9.	Band iron	1/16" th., 1/2" wide - 1/8" th., 1" wide
10.	Plexiglass	1/8"
11.	Plastic tubing	1/4" - 3/8" D.
12.	Copper tubing	1/4" - 1/2" D.
13.	Steel tubing	1/4" - 2" D.
14.	Steel rod	1/4" - 1/2" D.
15.	Plaster of paris	
16.	Sheet rock	1/2"
17.	Dowel rod	1/8" - 1"D.
18.	Clay	
19.	Sheet acetate	
20.	Cardboard tubes	1" - 4" D.
21.	Electric motors	slot car size to 1/4 hp.
22.	Slot car rear drive unit	
23.	Aquarium pump	
24.	Window screen	
25.	Fiberglass mat	
26.	Steel wool	
27.	Styrofoam	
28.	Rubber	
29.	Light bulbs	
30.	Poster board	
31.	Fasteners	
32.	Epoxy	
33.	Caulk	
34.	Solder	
35.	Brazing rod	
36.	Welding rod	
37.	Sandpaper	
38.	Emery cloth	
39.	Paint	
40.	Polyester resin	
41.	Catylist	
42.	Recyclable wastes: A. glass; B. sawdust, C. fly ash; D. grinding dust	

INTERDISCIPLINARY COOPERATION IN INDUSTRIAL ECOLOGY

With society's ever increasing awareness of the effects of pollution upon the environment, an educational void has developed. This vacuum, in the area of environmental education, requires a program through which all those involved can become more conscious of their effects on the environment.

To aid those interested in developing such a program, the Board of Regents of the State University of New York has developed guidelines for environmental education. These guidelines include:

1. Consideration of the total school setting - school structure, teacher-student relations, courses of study, and outside activities.
2. Multidisciplinary curriculum - due to the nature of the topic, the natural sciences have a major responsibility. The responsibilities of the social sciences lie in examining environmental problems from the social, political, and economic points of view.
3. Opportunities for outside activities - field trips, for example.
4. Inservice training for teachers - to help insure the success of an environmental educational program.
5. "Environmental education must raise basic questions of the tenets of industrial society, technology and economic growth." [1]

At no point in the proposed State guidelines is industrial arts mentioned. Yet it is stated that questions pertaining to the ecological aspects of industry and technology should be fostered. Based on the conclusions drawn by the participants in the Industrial Arts Ecology Pilot Program, it was found that industrial arts was best suited to investigate the technological contributions to the solutions of pollution problems.

Industrial arts should be an integral component of environmental education. Students can be directed to researching and constructing projects that are directly related to the industrial and technical aspects of pollution abatement.

In total cooperation, industrial arts, natural and social sciences, English, and language arts can serve to provide the student, and teacher, with a sound background for studying various areas of the environment as they relate to industry and technology. A specific example of the way in which departments can cooperate would be English aiding students studying Industrial Ecology with writing reports and business letters to industries.

[1] Environmental Education, State Education Department, Albany, N.Y., 3/71, p. 17

SUGGESTED INTERDISCIPLINARY ACTIVITIES

Skill	Suggested teacher
Library usage a. Researching b. Use of Guide to Periodic Literature c. Cross referencing	Librarian or English teacher
Letter writing Report writing Outline development	English teacher
Telephone conversation	Speech or English teacher
Orientation and introduction	Encourage other teachers in the school to correlate their activities with the Industrial Ecology curriculum.

TEAM TEACHING

The team teaching approach was utilized in the six pilot programs with success. Due to the independent nature of the students activities and the diversity of their subtopics, guidance must be at a premium. Team teaching facilitates lowering the student to teacher ratio to a workable level. A ratio of twelve to one is recommended. Having this source of teacher manpower in the classroom, the necessary amount of close supervision and monitoring was provided for each student. The selected reading, "Team Teaching: Psychological Implications," has been included to provide some insight to teachers desiring to operate a team teaching situation.

Due to administrative and budget considerations, team teaching is often not feasable. If this is the situation, there are other possibilities to which the teacher may avail himself.

A "Teacher Aid" can be helpful in the assistance in areas where teacher competence is not necessary, leaving the teacher free to concentrate on the more technical and specialized skills.

Guest speakers and outside "resource personage" can be of considerable help to the students by directing a student in a specialized area, with which they might have expertise.

Volunteering parents, college students or any other responsible adults can be well utilized to handle the many simple or non-technical problems that arise, letting the teacher make better use of his time.

The interdisciplinary approach will maximize the efficient use of a teacher's time. The section on "Interdisciplinary Cooperation in Industrial Ecology" in this guide discusses this in depth.

TEAM TEACHING: PSYCHOLOGICAL IMPLICATIONS[1]

By Henry R. Fea

Team Teaching, the sharing of instructional act or situation, is not new. Teachers have known about it and have used it in a variety of forms for generations. The various forms of team teaching have been described at length and in a number of publications. Its academic advantages have been discussed at length. But its effects on the personalities of the instructors and the students involved in team teaching situations have not been fully examined. In the hope that consideration from this viewpoint may prove of value, the following discussion is offered.

The Team Teaching Continuum

Consideration of interaction of students and teachers in team teaching situations is facilited by visualizing the team teaching situation as a continuum -- from minimum team teaching at the extreme left of the continuum to maximum team involvement at the extreme right. To simplify the discussion, consider a situation where, but two teachers and one class are involved if the operation is to be classified as lying at the extreme left of the continuum, the teachers will need to make but one decision -- a division of the content of the material to be taught to the class.

After this decision has been made no further communication is necessary. Each teacher will assume responsibility for presenting his portion of the subject matter to the class. Each teacher will select his teaching methods, texts, evaluative devices, teaching aids, and routine class procedures. When the class has run its alloted time each teacher will have contributed something in the way of skills, attitudes, behaviors and knowledge to the class. As there was minimal contact between the two teachers, it can be assumed that the team teaching situation toward this left end of the continuum contained the smallest amount of "Team" component it is possible to have in a team teaching situation.

If the operation is to be classified as lying at the extreme right of the continuum, the teaching behaviors will be completely complimentary (assuming that such a situation is practicable). There is one student body, an integrated body of knowledge, unified presentation and evaluation. The two teacher-personalties are complimentary -- where one is weak the other is strong. Where repetition from different viewpoints is wise the two teachers will provide it. This might be termed the ideal team teaching situation.

Any practical teaching situation in which team teaching is used will tie somewhere along the continuum between the two extremes described. The differences in effects upon personalities of teachers and students, as the situation lies more to the left or further to the right, are considerable. Consider, first, effect on teacher personality.

1 Fea, Henry R., "Team Teaching: Psychological Implications," Clearing House, November 1968, pp. 177-179

Teacher Personality and Team Teaching

According to study of personality and interpersonal relationships, the following psychological hypotheses appear justified:

(1) The further the actual team teaching situation is to the continuum (the direction toward least interaction between teachers), the greater will be the feeling of responsibility for the teaching outcomes in each teacher. Each teacher carries an unshared burden as it were. Conversely, the further the actual teaching situation is to the right on the continuum, (the complimentary situation), the less the feeling of individual responsibility should be. If, for example, I work with someone who is strong where I am weak, who stresses what I tend to avoid, I can relax in confidence that no important part of the learning behavior will be forgotten.

It would seem to follow that the teacher in the more isolated position because he feels more areas of sole responsibility, will contribute more nervous energy to his instruction -- driving hard to reinforce what he considers vital to the learning. The teacher in the complimentary situation will be relieved of much anxiety. Being related, the teacher in this situation will tend to be more original and creative in his teaching.

(2) The teacher in the isolated position will tend to feel more deeply committed to the outcome of the teaching, simply because he has the sole teaching responsibility for the outcome. Dedicated teachers have been considered, always, a boon to the students. On the other hand, the teacher in the complimentary position will tend to feel less deeply committed to the outcome of the teaching because the responsibility is shared. Because there is less emotional involvement, there should be greater objectivity, especially in crucial areas of diagnosis and evaluation. Objectivity has been considered an advantage, always, in such activities.

(3) Finally, a teacher in the more isolated position will tend to identify more closely with his students (the class is mine -- these are my students). The teacher is thrilled by the successes of his students and crushed by their failures. Closer identification usually leads to greater harmony and greater understanding.

A teacher in the complimentary situation may begin to experience a sense of loss of close identification because he is sharing these students with another teacher. This may result in the teacher unconsciously competing with the other teacher for student respect and admiration.

These three hypotheses are not facts. They have yet to be investigated in team teaching situations. But what is known of personality, and personal interaction suggests that they may prove to be true.

Pupil Personality and Team Teaching

Considering team teaching from the student viewpoint, the following psychological hypotheses appear justified:

(1) The students in the more isolated position should have a lower anxiety level. Anxiety is a product of uncertainty -- if students receive one answer to a question, are shown one way to solve a problem, they should tend to feel more secure.

In the complimentary teaching situation the students will hear different opinions from their teachers; they will receive explanations which differ in vocabulary; they will be shown alternate ways of solving problems. They may feel that the adults responsible for their education are not in accord in all things. Students want The Answer to a problem. It may be desirable to place students in positions where they must consider alternate answers -- but unresolved problems do create a higher anxiety level in the learner.

(2) Students in the more isolated position are likely to identify more closely with the teacher. Although this may produce more security, it may give students a tendency to attempt to solve their problems by the use of personal relationships rather than their best achievement, because the teacher is a personal friend.

As the teaching situation becomes more complimentary the level of identification tends to be reduced. The student, having more than one teacher, and therefore unable to concentrate his identification, is likely to feel that he can depend less on personal relationship with a teacher and must rely more on intellectual accomplishment to achieve his esteem.

(3) The isolated teaching situation should tend to produce more rigid student behavior. Since one teacher presents one mode of behavior, the student establishes a more rigid behavior pattern -- We do it this way. The complimentary situation -- involving interweaving of teacher behavior patterns -- should produce more flexibility in student behavior.

(4) Organization for teaching is much simpler in the isolated situation. There is no complete interweaving of subject matter, application, etc. This simple, straightforward organization is easier for students to follow. This means that it should appeal to the less bright and less creative student.

On the other hand, complimentary teaching situations lend themselves to complex organization. This should appeal to the brighter and more creative students, according to research into their preferences. The creative student, especially, seeks complex patterns of organization.

The isolated teaching situation places more responsibility for planning, and for putting plans into effects, upon the teacher, as previously mentioned. The complimentary situation tends to shift the responsibility from the teacher; therefore the student must assume more of the burden. The student must plan, coordinate, and accept general responsibility to a much greater extent in the complimentary situation. Thus, the complimentary situation should be preferable for more mature students, and for those whom teachers believe should be assuming more responsibility for their own learning.

(5) Because youth tends to extremes in its judgment, students judge teachers dichotomously, as either poor or good. In the isolated situation there is little opportunity for students to compare teachers because each teacher deals with different subject matter, habits, etc.

In the complimentary situation there is interweaving of teaching leaving a number of opportunities for direct comparison of teachers in action by students. As the students get more opportunity to compare teachers, the better teachers (as judged by the student) emerge as even better than reality (they can do no wrong). Less efficient teachers (as judged by students) emerge as even less efficient than they really are. This may create a situation such that students find it more difficult to learn from teachers they have labelled as less able.

Summary

In team teaching situations for the teachers, feelings of responsibility and identification may be reduced as the situation becomes more complimentary, but less anxiety and more objectivity may also accompany these feelings.

For students in team teaching situations for the teachers, feelings of responsibility and identification may be reduced as the situation becomes more complimentary, but less anxiety and more objectivity may also accompany these feelings.

For students in team teaching situations, as the situation becomes more complimentary, more anxiety, more complexity, and rejection of some teaching may result, but flexibility, independence, and creativity may increase.

None of these factors has been thoroughly investigated in team teaching situations. Psychologically, the ingredients for the hypothetical results described are present. Only extensive research in team teaching will supply final answers.

TIME ALLOTMENT

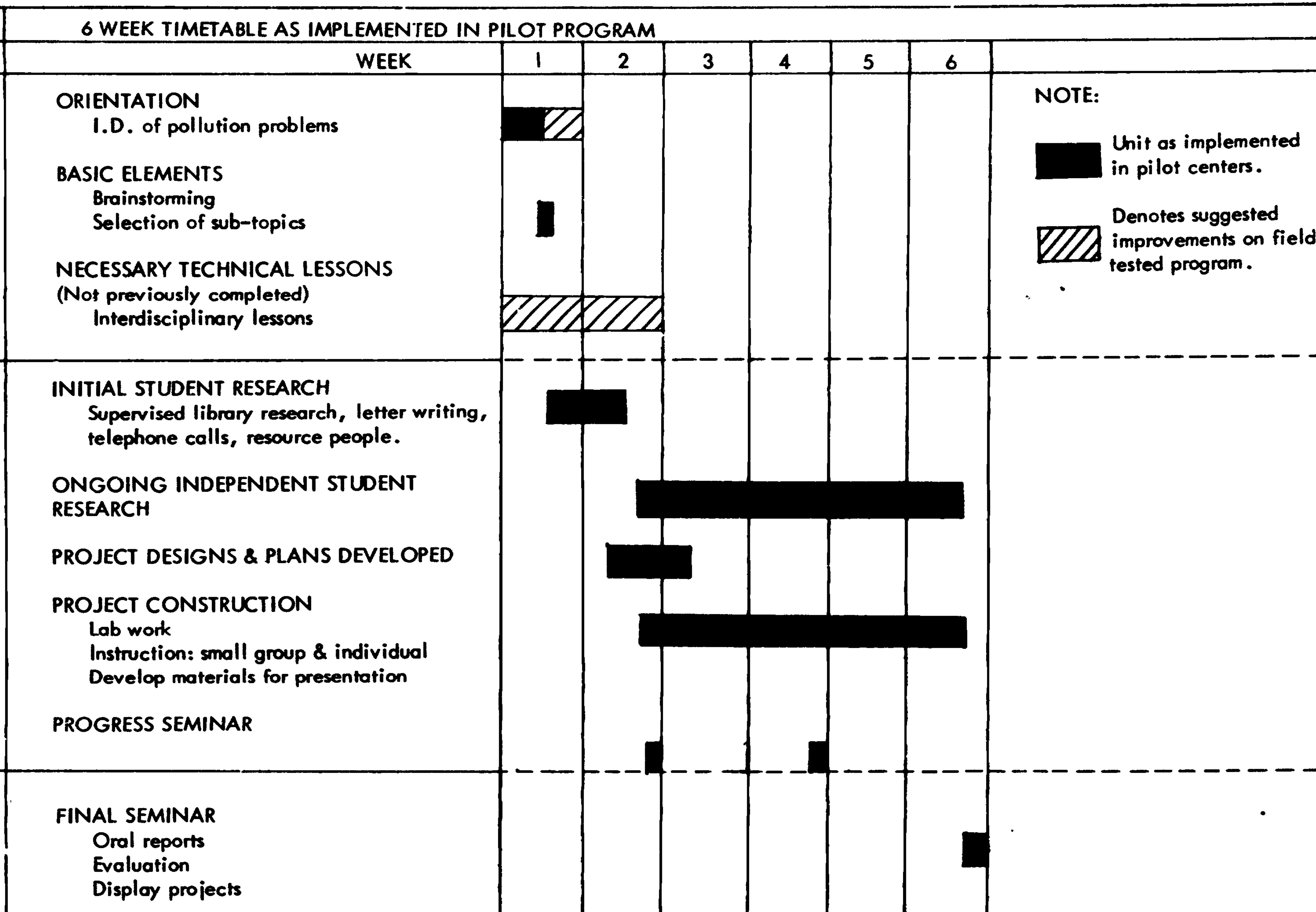
The Industrial Arts Ecology Pilot Program was implemented during the second half of the fall 1972 semester. The program lasted six weeks due to the Department of Industrial Arts and Technology student teaching experience in which the pilot program operates.

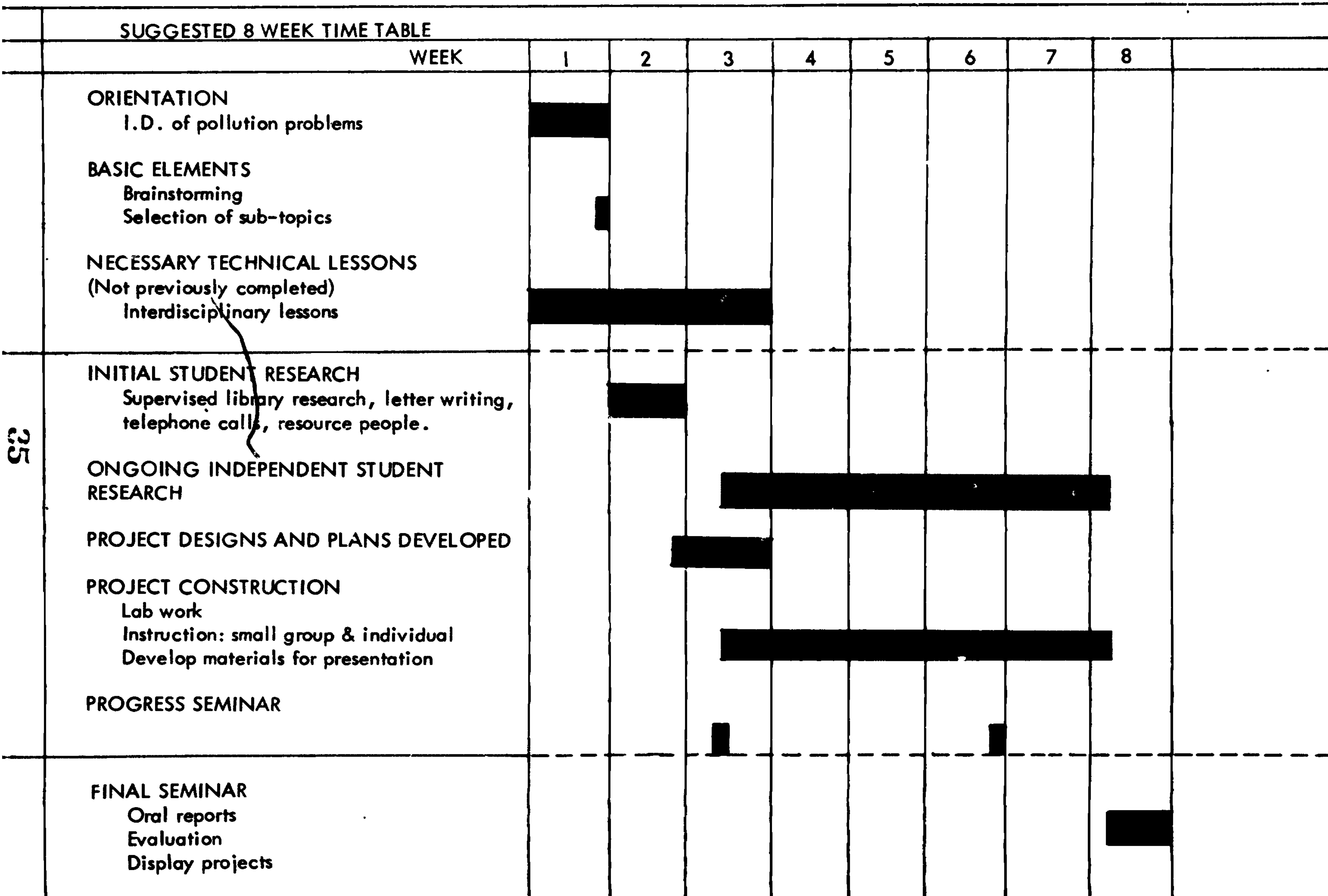
The student teachers cooperating in the pilot program found it difficult to implement the program within the six week time span. The teacher in the field, however, could possibly operate this program with more success under the same conditions and time allotment because of his experience in teaching.

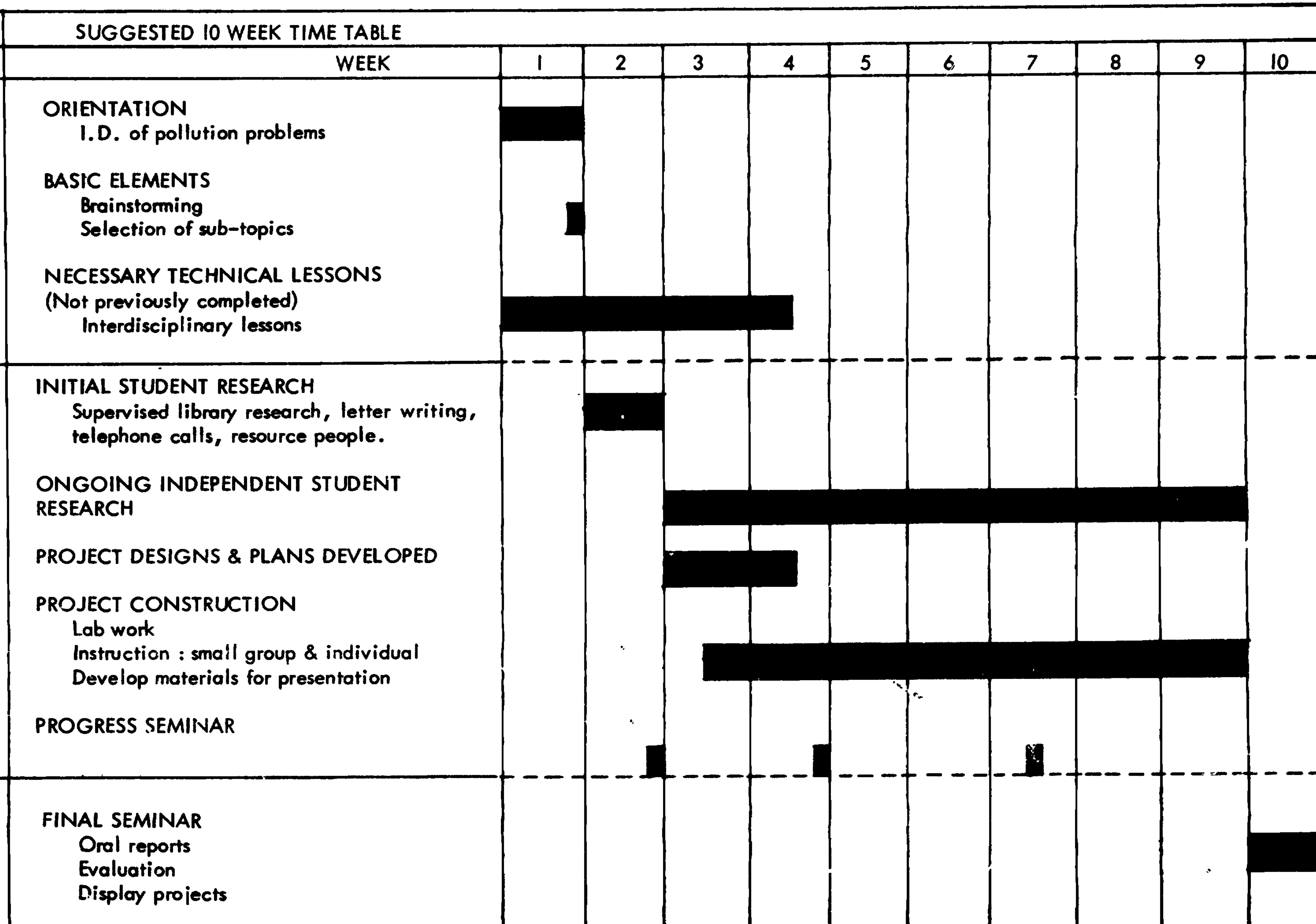
The time allotment for the six week program and alternate length programs have been included in the guide to allow each teacher in the field to be able to adopt the Industrial Ecology Unit to the design of his individual program.

In each schedule the time allotments, in relation to the activities, may vary depending on numerous inevitable circumstances and particular needs as the instructor determines necessary.

A time schedule combined appropriately with the individual programs and the instructor's experiences in education will likely yield considerable success.


6 WEEK TIMETABLE AS IMPLEMENTED IN PILOT PROGRAM
WEEK
1
2
3
4
5
6
ORIENTATION
I.D. of pollution problems
BASIC ELEMENTS
Brainstorming
Selection of sub-topics
NECESSARY TECHNICAL LESSONS
(Not previously completed)
Interdisciplinary lessons
INITIAL STUDENT RESEARCH
Supervised library research, letter writing, telephone calls, resource people.
ONGOING INDEPENDENT STUDENT RESEARCH
PROJECT DESIGNS & PLANS DEVELOPED
PROJECT CONSTRUCTION
Lab work
Instruction: small group & individual
Develop materials for presentation
PROGRESS SEMINAR
FINAL SEMINAR
Oral reports
Evaluation
Display projects
NOTE:
Unit as implemented in pilot centers.
Denotes suggested improvements on field tested program.


SUGGESTED 8 WEEK TIME TABLE
WEEK
1
2
3
4
5
6
7
8
ORIENTATION
I.D. of pollution problems
BASIC ELEMENTS
Brainstorming
Selection of sub-topics
NECESSARY TECHNICAL LESSONS
(Not previously completed)
Interdisciplinary lessons
INITIAL STUDENT RESEARCH
Supervised library research, letter writing, telephone calls, resource people.
ONGOING INDEPENDENT STUDENT RESEARCH
PROJECT DESIGNS AND PLANS DEVELOPED
PROJECT CONSTRUCTION
Lab work
Instruction: small group & individual
Develop materials for presentation
PROGRESS SEMINAR
FINAL SEMINAR
Oral reports
Evaluation
Display projects


SUGGESTED 10 WEEK TIME TABLE
WEEK
1
2
3
4
5
6
7
8
9
10
ORIENTATION
I.D. of pollution problems
BASIC ELEMENTS
Brainstorming
Selection of sub-topics
NECESSARY TECHNICAL LESSONS
(Not previously completed)
Interdisciplinary lessons
INITIAL STUDENT RESEARCH
Supervised library research, letter writing, telephone calls, resource people.
ONGOING INDEPENDENT STUDENT RESEARCH
PROJECT DESIGNS & PLANS DEVELOPED
PROJECT CONSTRUCTION
Lab work
Instruction : small group & individual
Develop materials for presentation
PROGRESS SEMINAR
FINAL SEMINAR
Oral reports
Evaluation
Display projects

SECTION 3

IMPLEMENTATION

INTRODUCTION

This unit is organized to assist the instructor in the primary and on-going phases of an industrial ecology program utilizing the unit method.

Enclosed in the following section are samples of field tested materials. These are designed to give the instructor examples of handouts, formats and suggested procedures A sample unit sequence, suggested lessons and a list of sub-topic and related projects are also included.

The interdisciplinary approach is strongly recommended. As the instructor reads this section it is suggested to note the points where instructional assistance is recommended. Prior to implementing the course the specific teachers should be contacted and request to assist.

Although many specific recommendations are made in this guide, it is recommended that due to the varying nature of students, shop facilities, and circumstances unique to individual, this guide remain flexible in its use. It is suggested that the flexibility lie in the use of the instructional aids. However, the students be involved in all of the basic elements of the course.

Please note: references to any suggested handout material will be found in this section.

OBJECTIVES OF IMPLEMENTATION

1. To guide the instructor through the primary and most critical stages of the unit.

2. To provide a reference for:

   A. Lessons to be taught before and during the research phase.
   B. Lessons which are related to the unit approach to Industrial Ecology.
   C. Field tested student sub-topics and student projects which have proved to be successful.

SAMPLE UNIT SEQUENCE

The following is a sample unit sequence designed to be used in conjunction with the suggested timetable in part II General Guidelines of the guide. These guidelines were written with the field experience in mind. The expected student outcome, industrial topics, student activities and instructional resources are planned with the timetable. The instructor may have to adjust the schedule to his needs. This is only a suggested sample sequence.

SAMPLE UNIT SEQUENCE FOR 8 WEEK
IMPLEMENTATION OF INDUSTRIAL ECOLOGY

Week 1

Expected Student Outcome	Instructional Topics	Student Activities	Instructional Resources
The student will identify pollution problems in the environment.	Introduction to course Environmental Problems and solutions using slide show.	View slides and movies of environmental problems.	Slides & movies showing environmental problems (See resource section)
Be aware of the scope of the unit.	Guest speakers Field trips	Identify environmental problems in pamphlets, booklets, and periodicals found in shop.	Handout sheet for in class assignments (Selection of sub-topic)
Recognize his responsibilities.	Criteria for selection of sub-topics (See handout sheet page	Brainstorming	Overhead projector using clean acetate
Selected subtopic on the basis of presented criteria.	List sub-topics and discuss possible projects. (See Section	Listen to guest speakers	Brainstorming
	Tech. Lessons where needed	Participate in Field Trips	Guest speakers Field trips

Week 2

Expected ' udent Outcome	Instructional Topics	Student Activities	Instructional Resources
The student will research project to build.	Lesson on reports (given by English instructor)	Three view drawing of report.	Handout - How tc write a letter (see page 23)
The student will draw up plans for building a project.	Library research to be conducted by the librarian	Using the phone to contact industries.	
Students will understand the format for writing letters.	How to conduct a phone call.	Begin planning.	
Students will know how to make three view drawing.	How to make a three view drawing.	Begin construction.	
	Technical lessons where needed		

Week 3

Expected Student Outcome	Instructional Topics	Student Activities	Instructional Resources
The student will describe the steps in construction of his project.	Lessons on material selection	Describe steps in construction of project	Procedure sheet
The student will select materials needed for construction of his project.	Lesson on project construction.	Select materials to build project.	
The student will write a report on his project.	Technical lessons where needed.	Continue research of project.	
Students will start construction on projects late in the week.	Small group instruction where needed.	Begin planning	
Students will start planning.		Begin construction.	

Week 4

Expected Student Outcomes	Instructional Topics	Student Activities	Instructional Resources
The student will: 1. Report his progress to the class up to this point. 2. Continue construction of his project.	Small group and individual demonstrations when needed.	In a seminar each student reports his progress up to this time. Continue research Continue construction Student Seminar	Seminar agenda sheets (See page 28) Overhead projector Grease pencil Acetate For Student Seminar

Week 5

Expected Student Outcomes	Instructional Topics	Student Activities	Instructional Resources
Students will continue construction on their project. Further research directed to the Report phase.	Small group and individual demonstrations where needed.	Work on individual projects using hand tools and machines. Continue research Continue construction.	As needed by the instructor to give small group and individual lessons.

Week 6

Expected Student Outcomes	Instructional Topics	Student Activities	Instructional Resources
The student will report to the class his progress up to this time. The student will continue construction of his project.	Small group and individual demonstrations when needed.	Each student will report his progress up till this time in a seminar. Research will continue. Construction will continue. Student seminar.	Use of the seminar agenda sheet (to be found on page 28)

Week 7

Expected Student Outcomes	Instructional Topics	Student Activities	Instructional Resources
The student will: 1. Contine construction of his project. 2. Begin to draw up a final draft of his report.	Lesson - Preparing a report. (with help from an English teacher if possible.) Small group Lessons and Individual lessons when needed.	Students will draw up final draft of their report. Continued research. Continued project construction.	Report format or outline (See page 30)

Week 8

Expected Student Outcomes	Instructional Topics	Student Activities	Instructional Resources
The student will present to the class his finished project and describe its operation. The student will finish contruction of his project. The student will write a final report. The student will evaluate himself.	Individual demonstrations when needed.	Work on individual projects. Final Seminar - Each student reports to class what he has built and how it cperates.	Final report handout sheet (See page 30)

SUGGESTED LESSONS

This section consists of particular lessons common to a course of this nature. Each lesson is discussed and references are made to related handouts in the following section of this guide. Lesson plans were not included here as it was felt that the instructor would be better able to work from his own plans in this area.

SUGGESTED LESSONS AND LESSON OBJECTIVES FOR THE INDUSTRIAL ECOLOGY PROGRAM

I. Introduction: (the student will)

A. Be aware of the scope of the unit. (The awareness of the environmental ecological problems and the study of the technological solutions to these problems.)
B. Recognize his responsibilities in the program. (See p. 18)
C. List topics and sub-topics. (See p.32-36)
D. Select sub-topic and project. (See p. 32-36)

The introduction should utilize instructional media (films, slides, etc.) to develop student interest.

The introduction will normally cover more than one day. Instructional time is well spent in the beginning to give students a broad scope of topics, sub-topics and projects. During the initial week guest speakers and field trips are suggested to increase the students awareness of technological solutions to environmental problems.

II. Reports:

From the field experience it has been conclusively determined that students at this level need direction in writing a report. The student teachers implemented forms such as those included (p30) which proved useful. It is suggested, however, that an English instructor present a lesson in effective report writing in conjunction with an outline handout. (p.30)

III. Library and Outside Research;

A) Library:

It is suggested that the students be afforded the opportunity to tour the library under the Librarian's supervision. Emphasis should be placed on planning and researching techniques. The instructor or the librarian should go through the steps of researching a specific sub-topic dealing with pollution abatement. This would assist the student by presenting him with a specific example of how to secure information for his individual sub-topic.

B) Letters:

A form letter has been included (p.23) to serve as a handout. Excellent results have returned through this medium. It is once again recommended that the English teacher present this to the class.

C) Phone calls:

Page 24 is a good suggested handout for students to utilize when contacting a source by phone. Good results were obtained using this form to assist students in securing information over the phone.

IV. The Seminar:

Periodic seminar meetings, directed either by the instructor or a selected student chairman, provide opportunities for students to exchange ideas, to seek help with research and construction problems, to assist one another, and to learn about each of the other class members' sub-topics. Students should know how to effectively participate in a seminar. (See p28) This will also aid in preparing the class for the final seminar which is the session in which students present the results of their research and project work.

V. Evaluation:

It is important that the students understand the evaluation process. The report, project, presentation, students attitude and behavior should all be consolidated to serve as a cumulative evaluation of the pupil. It is suggested that the students be involved in self evaluation and also in determining the weight of each section towards their final grade. A sample used during the Pilot Program is included (p.31) for a guideline.

VI. Drawings:

Students should be capable of preparing good drawings, sketches and orthographic projections, before beginning the construction phase of this program. Lessons on the following drawing methods are deemed necessary.

A) Oblique	
B) Perspective	SKETCHING
C) Orthographic	
D) Isometric	AND
E) Reading a rule	
F) Scaling	WITH INSTRUMENTS
G) Bill of materials	
H) Working drawing	

VII. Materials Selection:

The instructor should include lessons which review for the students the kinds of materials that are available for project construction. It is recommended to avoid the use of tin cans and cardboard in construction. Based on the field experience of the group it is advised that students extensively utilize the materials available in the shop. This is to give the students a good background with the tools and machines in the shop and to maintain a good degree of quality in the projects. Such items as tin cans, cardboard and balsa wood may be used when it becomes necessary to conserve shop resources.

VIII. Project Construction:

The working model, model, mock-up and prototype are ways in which a student can express his project. It is felt that a definition of these terms will prove valuable to the instructor in assisting the students in deciding what their project will consist of.

Model - an imitation or copy in miniature of something already made or existing on a large scale.

Mock-up - a scale model, usually a full size replica in wood, cardboard, etc., of a structure used for instructional purposes.

Prototype - an original or model after which anything is formed, the first of it's kind.

Working model - an imitation or copy in miniature of something already made or existing on a large scale which simulates or reproduces the function(s) or process(es) of the actual structure.

A sample model, mock-up, prototype or working model constructed by the instructor is recommended as a good example to present to the students. This would be well followed up through a discussion of how this was planned, constructed, fastened and finished. This should effectively describe to the student how to go through these phases of implementation. Individual assistance, however, will be necessary in many instances.

IX. Technical Lessons:

If the students have a weak technical background with the lab the following method is recommended.

A) The conceptual lesson method is suggested to preface the construction phase of the program. The conceptual lesson is designed to expose the students to varied procedures in one area. It differs from the demonstration lesson in that it does not go into the techniques of using tools, machines or equipment. The purpose is to expand the students' thinking when planning his project. Small group or individual lessons will be given to present proper use and safety measures.

E.G.

LESSON: Wood Cutting

OBJECTIVES: Students will be aware of all methods of cutting wood available in the shop.

MATERIALS: Backsaw, rip saw, crosscut saw, jig saw, saber saw, band saw, keyhole saw, miterbox saw, coping saw, etc.

PRESENTATION:
1. Brief discussion and demonstration of the purposes of each.
2. Technical lessons on the proper use of each tool will be given to small groups or individuals as per student needs.

CONCLUSION: Summarize as necessary.

1. WOODWORKING:

a. Layout
b. Cutting tools
c. Forming methods

d. Fastening methods
e. Finishing methods
f. Materials selection
2. METAL WORKING:
a. Layout
b. Cutting tools
c. Shaping tools
d. Fastening methods
e. Finishing methods
f. Materials selection.

B) The instructor should review student plans prior to the construction phase. While reviewing the plans he should decide what lessons he will need to present to small groups and individuals. This will allow for preparation and assist the instructor in efficiently alloting his time.

X. Presentation: (final seminar)

The purpose of the final presentation is to allow students to show the results of their research and project construction. It is suggested that students make full use of instructional media. They may use posters, transpariencies, handouts, etc. A class should be given before the final seminar to make the students aware of what is expected of them during the seminar. They should briefly discuss their sub-topic and project and how it is related to environmental ecology. Page 29 is a good suggested outline for this phase of the program.

THE UNIT METHOD

STUDENT INVOLVEMENT

AND ACTIVE PARTICIPATION IN...

RESEARCH

Collecting Information
Organizing Information
Presenting Information in Oral and Written Form

PLANNING

Designing
Drawing
Problem Solving
Planning with Others

CONSTRUCTION

Selecting & Using
- Handtools
- Materials
- Equipment

COURSE OUTLINE

1. SELECT A SUBTOPIC

2. RESEARCH A SOLUTION TO THE PROBLEM IN THE SUBTOPIC

3. WRITE AT LEAST ONE (1) BUSINESS LETTER FOR RESOURCE INFORMATION FOR YOUR SUBTOPIC

4. GIVE AN ORAL REPORT (and hand in a copy of the report) AT EACH SEMINAR ON PROGRESS OF RESEARCH AND DEVELOPMENT

5. MEET WITH A PERSON WHO CAN GIVE YOU RESOURCE INFORMATION (a person who is qualified to speak on the subject and can help you);

   VISIT A MUSEUM   VISIT AN INDUSTRY FOR RESOURCE INFORMATION

6. SELECT A MODEL OR DISPLAY TO MAKE THAT WILL SHOW WHAT INDUSTRY IS DOING TO SOLVE THE PROBLEM OF THE SUBTOPIC YOU HAVE SELECTED

7. DRAW PLANS AND GIVE STEP-BY-STEP BUILDING PROCEDURE AND LIST OF MATERIALS (cost and quantity) NECESSARY TO BUILD A MODEL OR DISPLAY

8. BUILD THE MODEL OR DISPLAY YOU HAVE SELECTED

9. PRESENT THE FINISHED PROJECT TO CLASS WITH AN ORAL REPORT ON YOUR RESEARCH

10. THE CLASS, AS A WHOLE, WILL SET UP A DISPLAY OF THEIR FINISHED PROJECTS.

STUDENT ACTIVITIES

RESEARCHING

INQUIRING

ANALYZING

PLANNING

ORGANIZING

CREATING

CONSTRUCTION

EXPERIMENTING

EVALUATION

REPORTING

CRITERIA FOR THE SELECTION OF A SUB-TOPIC

1. The sub-topic should support the major concept of the unit topic.

2. The sub-topic must encompass a technological approach to a problem.

3. The sub-topic must have implications for the future.

4. The sub-topic must lend itself to inquiry and investigation.

5. There must be information available on which to base the sub-topic.

6. The sub-topic must be of the students own choosing.

7. The sub-topic should be of interest to the student.

8. The sub-topic area should not be too restricting.

9. The sub-topic investigation must appear to be manageable in the time limits prescribed.

STUDENT SUBTOPIC OUTLINE SHEET

My Name ______________________________

My Unit Topic Is ______________________________

My Subtopic Is ______________________________

My Problem Is ______________________________

I Can Contact the Following People for Solutions:

Possible Solutions:

I Have Used the Following Books, Magazines, etc., for My Research:

I Have the Following Projects Which I Can Build:

RESOURCE CHECK LIST

RESOURCE	DATE CHECKED
1. INDUSTRIAL VISIT	______
2. MUSEUM	______
3. RESOURCE PERSON	______
4. BOOKS	______
5. FILMS	______
6. SLIDES	______
7. LETTERS	______
8. TELEPHONE CONTACT	______
9. MAGAZINES	______
10. INDUSTRIAL REPORTS	______
11. GOVERNMENT REPORTS	______
12. WORK SITES	______
13. SMALL GROUP INSTRUCTION	______
14. MODELS	______
15. NEWSPAPERS	______
16. INTERVIEWS	______
17. OTHERS	______

Instructors Note: It is highly advisable that this page be duplicated and distributed to students.

SAMPLE LETTER

(YOUR ADDRESS)

Mr. John Doe
Pollution Abatement Inc.
1000 Chestnut Street
New York, New York 13536

Dear Mr. Doe:

I am interested in some information concerning the process you use to recycle solid waste.

As a student in the 8th grade at the Campus School, Oswego, New York, I am working on a science project concerning Ecology. My topic of research is the recycling of aluminum cans. Through looking at resource material, I noticed that your company is involved extensively with the recycling of cans. Any information you can give concerning the amount of material you recycle, the cost of recycling, the problems encountered, and the steps involved will help me very much. Thank you for your cooperation.

Sincerely,

(Your name)

NOTE: This is only a form letter. And should be used as thus.

TELEPHONE PROCEDURES

1. Dial the telephone number of the company you wish to call.

2. Identify yourself and ask to speak with someone who can help you with whatever problem you are working on.

   EXAMPLE: Hello. My name is John Doe and I am in an ecology program at the Oswego Middle School. I would like to speak with someone who could give me some information on solid waste disposal. Thank you.

   REMEMBER: THESE PEOPLE ARE DOING A SERVICE FOR YOU AND YOU SHOULD BE COURTEOUS AND CONSIDERATE WHEN YOU DEAL WITH THEM.

3. When you are connected with someone who can help you, be certain to identify yourself again and proceed from there with whatever you have to talk with that person about.

4. Keep a list of telephone numbers of companies you call and the name of the person you speak to for future reference.

***

Telephone Call Log

COMPANY: ______________________________

ADDRESS: ______________________________

______________________ Zip Code: __________

TELEPHONE NUMBER: ______________________

PERSON TALKED WITH: ______________________ TITLE: __________

QUESTIONS TO ASK:

____

____

____

____

____

____

____

____

FUNCTIONS OF THE SEMINAR

1. Tie together individual abilities.

2. Reinforce the student's valuable regard for his work and reinforce his enthusiasm for his sub-topic.

3. Unify the group.

4. Provide opportunity for students to contribute to the efforts of others.

5. Allow students to participate in organized communication and to develop communicative abilities.

6. Assist students in becoming proficient in their ability to critically analyze, challenge, and question material presented.

THE SEMINAR

In order that effective communication and coordination of individual talents and skills might be brought about to a maximum degree, a technique referred to as the "seminar" has been developed as an integral part of the anthropological unit..

The seminar is by nature an organized and structured group meeting which meets periodically (usually weekly or every second week) or as particular class needs dictate. Experience seems to indicate that the physical facilities are best served by a large table or grouping of smaller tables which provide opportunity for ease in note taking, verbal communication, and the handing out of material. The tape recording of these seminars has had a significant value in attaining certain desired outcomes.

Seminars are conducted regularly throughout the duration of the unit study. The seminar is closely coordinated to the various unit activities in that it includes the following:

I. Introduction (seminar conducted by student chairman)
   A. Call to order
   B. Introduction of guests
   C. Summary of seminar's schedule.

II. Presentation of final reports of individual sub-topics if appropriate.

III. Current developments in the area of the unit topic (Trans. & Commun., or Tools and Machines, or Power & Energy)

IV. Progress reports on individual sub-topics. Each member of the class reports the progress made towards completion of his sub-topic since the last seminar. This report should include work on his model, problems encountered, phone calls made, interviews, field trips, and other activities. At the end of each report a short time is alloted for group questions and suggestions. The latter is a very important part of the seminar as other members of the class will often be able to present solutions to problems encountered or sources of additional information that would be helpful.

V. Closing Comments
   A. Visitors comments
   B. Instructors comments
   C. Student chairman's conclusions

SEMINAR FUNCTIONS

As a vital part of the unit, the seminar functions to:

1. Tie together individual abilities
2. Reinforce the value of work and enthusiasm for the group endeavor.
3. Unify the group
4. Provide opportunity for students to contribute to the efoorts of others
5. Allow students to participate in organized communication.
   (show and tell at a higher level!)
6. Assist students in becoming proficient in their ability to critically analyze, challenge, and question material presented.
7. Expose class members to the work of others.
8. Encourage students to think through their work in preparing it for presentation.
9. Encourage individuals to make progress so they have something to report.
10. Aid students in learning how to give constructive criticism.
11. Enable students to better accept criticism as a help to personal improvement and the successful accomplishment of the study project.
12. Make the class knowledgeable about a unit of information.

SEMINAR AGENDA

1. INTRODUCTION
   - A. Call to order
   - B. Introduction of guests
   - C. Summary of seminar's schedule.

2. PRESENTATION OF FINAL REPORTS OF INDIVIDUAL SUB-TOPICS IF APPROPRIATE

3. CURRENT DEVELOPMENTS IN THE AREA OF INDUSTRIAL ECOLOGY

4. PROGRESS REPORT ON INDIVIDUAL SUB-TOPICS.
   Each member of the class will report his progress toward the completion of his sub-topic since the last seminar. Each report should include work done on model, problems encountered, phone calls made, interviews, field trips, business letters written, resources used, and other activities. At the end of each report a short time is alloted for group questions.

5. CLOSING COMMENTS
   - A. Visitors comments
   - B. Instructors comments
   - C. Student chairman's conclusion

FINAL PRESENTATION

Be prepared to present your project to the class by displaying your project and explaining how it demonstrates a solution to pollution.

You may use posters, handout sheets, drawings, pictures, overhead transparencies, slides or any other materials you would like to use.

The final presentation will include the following:

Project: be able to explain the project using the technical terms that you have learned. You will want your fellow classmate to understand how it works and how it is used in our environment.

Display: any materials that you can use to help explain your project.

Report: You will be handed the format for the FINAL REPORT. Attach to the report, the drawing and procedure sheet that you have used.

NOTE: Spelling, neatness, knowledge of your sub-topic and display of your project will be marked. You may want to type or carefully handwrite your report.

INDUSTRIAL ARTS ECOLOGY PILOT PROGRAM

REPORT FORMAT

I. SUB TOPIC - IDENTIFY

II. PROBLEM

A. Statement of.
B. Possible Solution of.

III. PROJECT

A. Drawings
B. List of Materials
C. Equipment Used
D. What is it?
E. How does it relate to problem?

IV. BIBLIOGRAPHY

A. Books
B. Magazines
C. Pamphiets
D. People contacted.

REFERENCES:
Author, "Name of Article," Name of Magazine, Date, Page Number

Example: Young, G., "Pollution Threat to Man's Only Home," National Geographic, December, 1970, pp. 738-780.

INDUSTRIAL ARTS ECOLOGY PILOT PROGRAM EVALUATION

Name ______________________ Sub-topic ______________________

Problem: How does technology...

CRITERIA	Project Maximum	Student	Instructor
Report - (grammar, spelling, punctuation, outline, content)	25	______	______
Project - (construction, craftsmanship, idea planning, design, materials)	40	______	______
Presentation - (voice, language, knowledge of topic) 15	15	______	______
Attitude - (teachers, fellow students, program)	10	______	______
Behavior - (in class, extra periods)	10	______	______
TOTALS:	100		

	Needs Improvement (E)	(D)	(C)	(B)	Very Good (A)
ATTENDANCE	(E)	(D)	(C)	(B)	(A)
RESEARCH	(E)	(D)	(C)	(B)	(A)
a. Letters written					
b. Phone calls					
c. Visits					
d. Materials obtained					
e. Research guide					
f. Evidence of research in report body					
g. Report bibliography					
h. Knowledge of subtopic exhibited in class					
PROJECT PLANNING	(E)	(D)	(C)	(B)	(A)
a. Illustrates technological solution to pollution					
b. Sketch					
c. Evidence of good planning during work period					
PROJECT CONSTRUCTION	(E)	(D)	(C)	(B)	(A)
a. Trying to do good work					
b. Evidence of good student workmanship					
c. Emphasis on technological solution to pollution					
WRITTEN REPORT	(E)	(D)	(C)	(B)	(A)
a. Readability & spelling					
b. Coverage of subtopic					
c. Emphasis on technological solution to pollution					
PRESENTATION	(E)	(D)	(C)	(B)	(A)
a. Knowledge of subtopic illustrated					
b. Emphasis on technological solution to pollution					
c. Student attitude while others presenting their topics					
ATTITUDE	(E)	(D)	(C)	(B)	(A)
a. Clean up job					
b. Getting things in on time					
c. Willing to spend time on things to do them right					
d. Follows shop safety rules					
OVERALL GRADE FOR PILOT PROGRAM	(E)	(D)	(C)	(B)	(A)

TOPICS, SUB-TOPICS AND RELATED PROJECTS

The following list is provided to aid the instructor during the introduction phase of the program. The list is divided into four general areas; Air Pollution, Water Pollution, Noise Pollution and Solid Waste Pollution. Each area is further sub-divided into sub-topics. Every sub-topic has at least one related project.

These are only suggested sub-topics and projects. It is recommended that the student choose his own sub-topic and related project subject to the approval of the instructor.

AIR POLLUTION

Jets - Filtering Jet Exhaust
Ind. Stacks - Model Electrostatic Precipitator
Sulfur Oxide - Wet Scrubber
Pesticides - Farm Model, Effects of DDT
Emission Control - Afterburner
Auto Exhaust - Model, Catalytic Converter
Auto Exhaust - Monitoring System
Auto Exhaust - Cyclone Air Cleaner
Auto Exhaust - Electric Car
Auto Exhaust - Filter Bag
Smoke - Smoking Machine, Analyzer
Exhaust - Muffler Baffle
Cars - Monorail
Exhaust - Engine Model
Exhaust - Rotary Engine Model
Cars - Steam Powered Car
Industrial Stacks - Bag House
Rocket Exhaust Model Rocket

WATER POLLUTION

Detergents - Filtering System
Water Filtration - Filter Display
Oil Spills - Clean Up System, Floating
Sewage - Trickling Filter Plant
Sewage - Model of Treatment Plant
Sewage - Sewage Treatment Filter
Oil Spills - Scooper, Chem. Controlling Agent Demonstration
Sewage - Settling Tanks
Sewage - Tertiary Treatment

SUB-TOPICS AND PROJECTS

SOLID WASTE

Recycle Cars - Crusher
Paper - Shredder
Oil Refinery - Model of Refinery
Recycle Bottles - Making Glassphalt, Glass Floor, Chicken Grit
Human Bodies - Model of Crematory
Tires - Tire Making Machine
Landfills - Cross Sectional Model
Cans - Crusher
General - Hydrosposal
Alum. - Foundry
Paper - Plant Model
Garbage - Compacter
Litter - Posters, Survey
Waste - Constructive Uses for Ash (Bricks)
Waste - Fragmentizer
Erosion - Breakwater, Storm Drainage
Cars - Landfill

NOISE POLLUTION

Jets - Filtering Jet Exhaust
Noise - Sound Proof House
Lawnmover - 2 cycle Engine Muffler
Jets - Airport Mockup
Cars - Electric Car

MISCELLANEOUS

Solar Power - Solar Battery or Panel
Nia. Mohawk - Waterwheel to Modern Plant
Model of Power Plant
Thermal - Cooling Tower
Nuclear - Nuclear Reactor
Thermal Fence - Hearing Building with Steam Exhaust

SAMPLE REPORTS

The next section of the packet includes sample reports from students. These reports have been left in the form as presented by the students. Some are presented using the outline form and others utilize a questionnaire format. Samples are included of both forms to help the instructor determine which will be best implemented in his situation. These reports are also enclosed to afford the instructor an insight into what students of this level are capable of in report writing.

SUB-TOPIC

Industrial Waste from Smokestacks

HOW DOES INDUSTRY SOLVE THIS PROBLEM?

Industry solves the problem of air pollution from smokestacks in a number of ways. One method is the afterburner method where any pollutant that is burnable but hasn't been burned completely is burned again so that there are no unburned gases being given off into the atmosphere to pollute it.

Another method is the electro-static precipitator. It consists of two copper plates and a very thin wire. The plates are charged with electricity using a negative charge. The wire charged positively. As particles pass the wire they are charged positively and then as they pass the plates which are charged negatively the positive particles are attracted to the negative plates. The particles stick to the plates until they are cleaned off.

Both of the above methods are used by industry today. At some plants they are ovens used together to get the air as clean as possible. Unfortunately not all plants employ such good methods as the ones above, some just use a simple filter which does not stop all the pollutants from entering the atmosphere. Some of these filters consist of merely some filtering agent such as spun glass, fiberglass, and a metal mesh. If the industries of today would spend more on pollution control things might be in better shape than they are.

ARE THERE ANY OTHER WAYS TO SOLVE THIS PROBLEM? EXPLAIN THEM.

There are at the time not any other feasible means other than the one I have mentioned. There are such ideas as the cathilytic converter, but it is too expensive to be practical. There are variations on the ones I have mentioned but they are generally the same.

LIST THE EQUIPMENT THAT YOU WILL USE IN YOUR PROJECT...

For the project I will need the use of the drill press, the box and pan brake, the bar fold, the welder and a propane source.

LIST THE MATERIALS THAT YOU WILL USE IN YOUR PROJECT...

I will need 1 28 sq. in. (possible 164 sq. in.) of fairly heavy sheet metal, 9 in. of 5/8 inch piping, two feet of copper tubing, soldrer, a pollution source (preferably a gas that will burn)

LIST ALL THE REFERENCES THAT YOU HAVE USED IN GETTING INFORMATION FOR YOUR PROJECT. (BE SURE THAT ALL REFERENCES LISTED ARE ON PG. 2 OF YOUR BOO..LET.)

I have used an entire set of World Book Encyclopedia, Mr. Prohaska, Mr. Musco, Mr. Bollenbacher, Mr. Figurski, the booklets on the top desk, my father.

WHAT IS THE PROBLEM AREA, AND THE SPECIFIC PROBLEM YOU ARE REPORTING?

The problem area that I am working on is air pollution. The specific problem is unburned gases that escape through factory smokestacks, such as sulphur that escapes and causes a rather pungent odor to fill the air.

The process that I am employing is already in use in some of the larger factories. It is used in aircraft, but as a means of getting more power rather than a pollution control device.

HOW DO YOU PLAN TO SOLVE THE PROBLEM IN THE LAB?

I plan to solve the problem in the shop by construction of a simulated incinerator that would simulate gases being given off by a factory incinerator. Then these gases are piped into a second burning chamber where these gases are burned again by means of a fuel inlet where a non-polluting fuel is ignited and introduced to the unburned gases and they are burned again.

In the following text I shall explain how to construct the second burning chamber. Cut sheet metal pieces; a 2x16, 3 5x4.* Allow half an inch hems on one of the 2x16 pieces. Measure 14 inches in from each end of each piece of 2x16. Drill a 5 inch hole in the center of the two inches in the middle of each strip of 2 x 16. Drill a 1 inch hole from 2 inches up from the bottom of the chamber walls. (one of the 14 inches measured from the 2x16.)

Bend the metal on the 14 inch line from both sides of both strips. Bend the hems on the one strip that you decided to use. NOTE: On the strip that has the hems you must compensate for the hems so the strip with the hems will actually be 3x17. Weld the strips together at the seams. Braize the 5/8 inch pipe to the 5/8 inch hole and the copper tubing to the 1/4 inch hole.

* not a necessary part of the unit but may be used.

SUB-TOPIC

1. Air Pollution
2. How is technology solving air pollution injets.
3. PROJECT: Model of TURBOJET ENGINE
    A. Drawings
    B. Materials
        1. Wood 28" by 2"
        2. 2 13" metal stock
        3. 28" by 3" pc. of wood
        4. Stain
    C. Equipment Used
        1. Lathe
        2. Drill Press
    D. Projects relation to the problem -

This project is related to the problem of air pollution caused by jets. Pollution in jets is a very big problem which has to be solved. Some methods of stopping air pollution have been successful while others have been unsuccessful. Every jet engine manufacturing company has tried to make a jet engine that will reduce the Noise and Air pollution on levels.

Now take the SST for example. That plane would have been a manufacturers dream, only they had to go against it because of, in my opinion, the great cost of money involved in the building of it, was the reason.

4. BIBLIOGRAPHY
    A. Books - The Golden Home and High School Encyclopedia #10
    B. Magazines - None
    C. Pamphlets - None
    D. People and Places contacted:
        1. Federal Aviation Authority

MATERIAL LIST

QUANTITY	SIZE	DESCRIPTION
1	28" x 2-1/2"	Piece of hardwood which is to be used for the turbojet.
2	13"	Pieces of metal stock which is to be used for support.
1	28" x 3" x 1"	Piece of wood which is to be used for the base

CONSTRUCTION PROCEDURE

1. Get 28" x 2-1/2" piece of wooden stock, after you've drawn up plans.

2. Put the wood on the lathe and proceed to dig out the wood at interval as going down 1-1/2".

3. After digging it out you take sandpaper and sand out the turbojet until it is very smooth.

4. Then you take another finer piece of sandpaper and proceed to smooth it out to the desired smoothness.

5. Next you drill 2 holes on either end and proceed to bend 2 pieces of 13" metal stock at an 90 degree angle and put into turbojet.

6. Put turbojet back on lathe and (with desired color stain) stain turbojet by dipping cloth in the stain and putting cloth under project press up lightly for light color and hard for dark color.

7. Get a piece of wood for the base.

8. Stain base and paint supports.

9. Put turbojet on base.

10. Put on the name tag.

SUB-TOPIC SOLID WASTE

PURPOSE OF SUBTOPIC RESEARCH: The purpose of my subtopic research on the subtopic SOLID WASTE was to investigate methods of reducing solid waste that is not recyclable and compacting it to take up much less room.

WHAT IS THE PROBLEM:

The pollution problem caused by the disposal of unrecyclable solid waste is a big hardship to the American person for if solid waste could be compacted it would take less room to store. On that extra ground could be built houses, apartment buildings, playgrounds, stores; almost anything.

POSSIBLE SOLUTIONS:

One possible solution would be recycling the materials, however, not all materials can be recycled.

Plastic could be remelted and molded again into the same thing or something different.

Two advantages of recycling would be: 1) it would cut back the quantity of solid waste which needs ultimate disposal. 2) It would cut the quantity of resources mined pumped or cut and extend raw material supplies.

Another possible solution for the disposal of solid waste would be to compact the waste material into a much smaller size and thus take up less room. An advantage of this would be that the compacter could crush all the material into little blocks about 3 feet by 3 feet and then they would be stacked up on top of each other neatly and thus would take up about one-third of what was originally taken up by the waste.

WHAT IS MY PROJECT AND WHAT DOES IT ILLUSTRATE:

My project is a garbage smasher more commonly known as a compacter, it shows that if solid waste was compacted it would take much less room to store. My project is a miniature compacter. The kind that are in some of our houses are much smaller than the kind that would be used to compact solid waste, and they would be much more power on the mechanically run handle.

BIBLIOGRAPHY

People, places, books, etc...where I obtained information on my subtopic.

(PEOPLE)
Mr. Robert Becker, Gen. Mgr., Onondaga County Solid Waste Auth., Syracuse, New York
Environmental Protection Agency, Cincinnati, Ohio
Ford, Bacon and Davis, New York, New York

(MAGAZINES)
"Power," The Case for a Solid Waste Disposal, Utility, May 1971

(PAMPHLETS)
"Environmental Control and the Consulting Engineer," Ford, Bacon and Davis.
"Closing Open Dumps," Environmental Protection Agency, 1971
"Sanitary Landfill Facts," U.S. Bureau of Solid Waste Management, 1970
"Recycling," U.S. Environmental Protection Agency, 1972
"Recycle," League of Women Voters, 1972
"Let's Dump the Dump," U.S. Environmental Protection Agency, 1971

SECTION 4

BACKGROUND INFORMATION

Section 4 BACKGROUND INFORMATION*

JUSTIFICATION FOR VISUAL SUPPORT PACKAGE

The following pages contain numerous sketches, drawings, descriptions, and technical illustrations of forms of pollution abatement technology. In providing the instructor with this material, it is hoped that possible student project ideas can be generated, and that both student and teacher can gain a better understanding of the particular control system to be researched.

BACKGROUND INFORMATION

Section I contains basic information on pollution and pollution abatement equipment that is suggested for review by the instructor. It is designed to give the instructor a general understanding of the areas of pollution and pollution abatement systems. It may also be used as a resource for student research.

DRAWINGS OF POLLUTION ABATEMENT EQUIPMENT

Section 2 contains articles, advertisements, and drawings of pollution abatement equipment that should prove very helpful to an instructor implementing this unit. The information in this section is suggested for review by both students, and the instructor. In the student's case, this section aids in the areas of project selection and construction, while the instructor benefits from additional background and direction for the class.

DRAWINGS OF POSSIBLE STUDENT PROJECTS

Section 3 contains potential student projects, based on subtopics previously explored by students in the INDUSTRIAL ARTS ECOLOGY PILOT PROGRAM. It is suggested that these drawings, as those in Section 2, be used as devices to aid both student and instructor.

*Note to Instructor: The materials supplied in this Background Information section are suitable for duplication as student handout sheets and for the development of transparencies for class instruction.

PERSPECTIVE ON POLLUTION*

Environmental pollution is generally classified into the three primary areas of air, water and land (solid waste) pollution and the three secondary areas of radiation, pesticides and noise pollution. In terms of greatest public awareness, industrial concern accompanied by abatement measures, and legislative emission standards and controls air pollution ranks number one. Although water pollution presents serious consequences to the ecological life cycle, the average tax paying citizen is likely to look beyond the polluted river or stream to the more tangible and growing problem of solid waste disposal which is known as the "3rd Pollution" in the hierachy of contaminant areas. Radiation, the use of pesticides and noise are problems that are receiving corporate and governmental attention, but they are least recognized by the populace, primarily because they cannot be observed directly. Air pollution, water pollution and solid waste usually confront us daily.

Air Pollution is chiefly caused by the burning of fuels for heat and power, industrial processing, and from the combustionable disposal of industrial and municipal wastes. The sources of air pollutants are industry, power plants burning fossil fuels, motor vehicles, space heating and refuse disposal plants (also open burning). Sulfur Oxides and particulate matter are the two major air pollutants. They account for 30 percent of the 210 million tons of waste poured into the air annually over the United States.(1)

The major source of the sulfur oxides is the burning of the fossil fuels coal and oil which contain significant amounts of sulfur and give off large amounts of sulfur dioxide and lesser amounts of sulfur trioxide. Although the sulfur dioxide is a colorless, nonflammable and non-explosive gas, it is highly soluble in water and its pungent and irritating odor can be smelled and tasted in the air. Sulfur dioxide reacts with water to form sulfuric acid and sulfuric acid salts which are dangerous to the lungs and the dioxide gas irritates the upper respiratory tract.

Particulate matter are the minute pieces of solid materials which are caused by combustion and dispersed into the atmosphere. These constitute a significant portion of the pollutants in city air. Composed of bits of carbon, fly ash, oil, grease and microscopic amounts of metal and metal oxides, particulates are the dust, smoke, haze and mist that are so easily seen (1). Carbon Monoxide and hydrocarbons are discharged chiefly by the automobile. The former is noticed in heavy traffic and produces headache, loss of visual acuity and decreased muscular coordination. The chemical hydrocarbons play a major role in the formation of photochemical smog.

The major industrial contributors of gaseous and particulate air pollution are: pulp and paper mills; iron and steel mills; petroleum refineries; smelters; and inorganic and organic chemical manufacturers.

* Taken from: Figurski, Arthur, G., Environmental Education Resource Guide
Department of Industrial Arts & Technology
State University of New York
College of Arts & Science at Oswego

Water Pollution comes chiefly from industrial, municipal and agricultural sources. There are more than 300,000 water-using industrial plants in the United States of which the paper, organic chemicals, petroleum and steel groups discharge most of the process wastewater. Municipal wastes include domestic wastes from homes and other dwellings, and commercial establishments. A considerable amount now slightly over 40 percent of industrial wastewater, is processed by municipal waste treatment plants. Agricultural wastes are caused by the use of chemical fertilizers containing nitrogen and phosphorus and by animal wastes which are diffused to the water. The use of pesticides also presents a water pollution problem. Point and diffuse sources of water pollution produce sediment, nutrients, pesticides, silt, salts, oil, sewage, phenols, acids, alkalies, heat solid wastes, radioactive materials, heavy metals, bacteria and viruses, detergents, floating and settleable solids color, organic and inorganic materials, dissolved solids, bio-chemical and chemical oxygen-demanding wastes, and toxic and inert material (2). If one were to compare industrial water pollution to municipal water pollution from organic wastes it is equivalent to the amount of municipal wastes produced by 210 million people.

The quality of wastewater is often measured in terms of its biochemical oxygen demand (BOD) or the amount of dissolved oxygen that is needed by bacteria to properly decompose the wastes. Manufacturing activities, transportation and agriculture account for two thirds of all water pollution.

Solid Waste Pollution covers a growing category of unwanted, leftover substances generated in the course of producing, processing and consuming useful products. Agricultural wastes consisting of animal wastes, animal carcasses, crop residues and logging debris are the largest source of solid waste -- 2 billion tons annually. Mining and mineral processing wastes are about 1.5 billion tons a year.

Although 95 percent of all solid waste is produced in the processing of natural resources, the major problem of solid wastes disposal is the remaining 5 percent of garbage, rubbish, ashes, and municipal refuse. This paradox is due to the location of the respective sources. Resource mining occurs in sparsely populated areas where solid wastes can be effectively disposed of, whereas the "garbage" problem is caused by and occurs in the heavily populated metropolitan and suburban areas. The growing problem of solid waste disposal is caused by increased population, increased consumer purchasing power, consumer distaste for reconstituted materials, and the tremendous increase in non-returnable items of glass, plastic and paper. The packaging industry alone accounts for 35 million tons of refuse annually.

Refuse is processed to reduce its bulk and subsequently reduce collection, storage, transportation and disposal costs. Common processes are mechanical compaction and communication, open burning, incineration, pyrolysis and composting.

The Role of Industry

American industry is not the sole offender on the pollution scene, yet many are quick to generalize and brand all industry with the black hat syndrome. Today's affluent populace is easily influenced by negatively skewed environmental rhetoric advanced by self-styled ecologists. One should be highly selective in reading materials dealing with the environment issues. Industry is playing an increasingly expanding role in the control of pollution through the strategic application of its abundant resources, including personnel research activities and technologies. Most larger corporations have reorganized to create environmental control departments or groups which team up with or replace existing process engineering departments. What has prompted industry's improved emphasis on environmental control? Although many manufacturing and service industries have always been concerned about their social image and have paid close attention to maintaining pollution standards, others have not. Today those who form the latter group are also moving in the direction of increased pollution abatement programs in answer to federal and state legislation which establishes emission standards for air and water. Numerous exemplary pollution abatement programs preceded federal measures and were the result of farsighted, sensitive corporate action.

The space provided here does not permit the analysis of the far-reaching social, political and economic implications of controlling pollution, but they do exist, and you and your students will become aware of them as you embark on environmental education activities. An overview of some of the existing anti-pollution equipment and abatement technologies being used by industry will provide you with a basic orientation which will enable you to better direct your students in their study of and activities with the technology dimensions of environmental pollution and pollution control.**

Abatement Technology: Air Pollution

Dry mechanical collectors are used to collect particulate matter and are of two general types; settling chambers and cyclone collectors.

Settling chambers -- particulates are removed as force of gravity pulls them to the base of the chamber.

Cyclone collector -- particulates are pulled out by centrifugal force.

Wet scrubbers can remove as much as 99 percent of particulates air stream by spraying or forcing the contaminated air through a series of liquid baths.

Fabric filters operate much the same way as does a vacuum cleaner. The industrial air stream is drawn through a series of cloth or fabric bags or envelope while large dust pieces are caught in the bags.

** Taken from "Businessman's Environmental Dictionary," Industrial Ecology. (temporarily out of publication)

Electrostatic precipitators are multiple units which operate by passing the air stream through a strong electric field. As gases pass through the electric field, suspended particles pick up the negative charge and are drawn to a collecting electrode. Precipitators can remove as much as 99.9 percent of all particulates.

Gaseous Control Devices

Chemical Absorbers use chemicals to suck the polluting gases from the air stream before they are discharged through the stacks.

Chemical absorbers condense the gas on the surface of a hard surface, usually carbon, before discharge.

Abatement Technology: Water Pollution

Primary water treatment includes the preliminary screening for sticks, rags, and other debris and the use of settling chambers. Although primary treatment does not improve the water quality, 30 percent of the countries municipal sewage facilities are serviced by only primary treatment systems.

Secondary water treatment consists of aerobic and anaerobic systems that cause microoorganism conversion of organic wastes into carbon dioxide.

Tertiary water treatment is the most sophisticated and effective. Water is subjected to various chemicals which absorb the effluents, dissolve them, render them harmless or cause them to coagulate, settle or rise to the surface of the water where they are removed mechanically.

Distillation processes are used to separate waste from water by heating the H_2O until it rises as a mist, collecting and cooling the mist which turns back to a liquid apart from the pollutants.

Electrodyalysis is the water what electrostatic precipitators are to the air. This is a form of tertiary treatment whereby effluents are separated by means of electric charges.

Reverse osmosis is used in desalinization operations and is a process that forces water through a series of membranes which prevent pollutants from going through.

Abatement Technology: Solid Wastes

Pneumatic collectors are used to draw off production line scrap or like properties to a central plant location. A duct system is used to collect the materials.

Grinders, shredders, crushers and compactors are used to reduce the volume of waste materials before they are reintroduced into the production line or disposed of.

Mechanical separators segregate various kinds of materials within the waste mix to facilitate recycling.

Incinerators are used to reduce solid waste volume. Closed incinerator systems have been introduced which use the heat resulting from the combustion process to heat buildings, thus reducing fossil fuel burning and resultant sulfur dioxide.

Pyrolysis is a form of incineration in which combustion takes place in the absence of air. This process enables a higher percentage of the wastes to be reclaimed.

In addition to the pollution abatement systems described above, numerous innovative techniques for controlling air, water and solid waste pollution are in the research and development and pilot model stages. Antipollution industries such as Research-Cottrell, Western Precipitators, Carborundum, Wheelabrator and Zurn Industries are involved in manufacturing much of abatement equipment cited (4, p. 114).

Pollution abatement equipment is expensive, especially when it has to be installed on an existing plant, what is termed in the industry as "back-fitting." The average cost per installation of a precipitator, which you recall are usually in multiples is one and a half million dollars. Regardless of the industry, pollution abatement equipment is almost automatic in new plant development and construction. It has been estimated that the average corporate budget includes 10 percent for pollution control.

Consulting Engineering Firms

Throughout industry environmental engineering and consulting firms are becoming very popular, especially for the smaller operation that cannot afford their own specialized equipment or environmental research groups. The role of the consulting firms will increase as industries seek expertise to identify and reveal solutions to their respective and oftentimes unique pollution problems, require hydraulic models of equipment for new facility planning, and need the advantage of a third party viewpoint for decision making or court case strategies. Many consulting firms are selling their services in the form of comprehensive air and water monitoring programs which assist the purchasing industry in maintaining local and/or federal emission standards.

Industrial Association Functions

In addition to the role of the individual industries, industrial groups and organizations such as the National Association of Manufacturers, American Iron and Steel Association, Automobile Manufacturers Association, Society of the Plastics Industry, and the Aluminum

Association have developed comprehensive programs of research, state of the art studies, and in-house and public oriented literature designed to promote a factual awareness of the real problem of pollution. These groups will be especially helpful when attempting to secure specific information about various industrial groups. As one example, the National Association of Manufacturers has established an Environmental Quality Committee which consists of over 100 representative industries from all parts of the country. This group recently conducted a Conference on Pollution which dealt with how industry will meet the standards being established by the federal government.

National Association of Manufacturers: Environmental Quality Committee

NAM's Environmental Quality Committee was established in 1970 for the purpose of coordinating and communicating some of the pollution control efforts of member industries and providing for cooperation and liaison among those industries having similar pollution problems or employing similar abatement strategies.

Each company on the Environmental Quality Committee is represented by that corporate individual specifically in charge of environmental activities at their respective plant. Also included on the committee are representatives from environmental consulting firms and engineering services groups. Manufacturing Trade and Services Industries are represented.

Although the members of the Environmental Quality Committee are only representative of those industries involved in on-going environmental action programs they provide a good cross-section of various kinds of manufacturing and service industries and provide a good resource listing for the industrial arts teacher or student requiring additional information about specific pollution problems pertaining to selected industrial processes or operations. Most companies are willing to share the pollution control activities with interested parties, primarily in the form of special annual reports or publications or news releases describing their corporate or local plant abatement efforts.

BACKGROUND INFORMATION

on

AIR POLLUTION CONTROL

The chemical industry's total responsibilities in environmental health begin within its own manufacturing facilities. The industry's expertise in control of emissions has developed from its historic ability to control in-plant hazards of toxic materials. This expertise and concern has, over the years, been translated into effective control of emissions to the general atmosphere.

NATURE OF THE PROBLEM

Not all chemical manufacturing involves atmospheric discharges: a Manufacturing Chemists Association survey in 1967 showed that roughly one-third of chemical manufacturing processes produce no routine discharge of gases, mists or dusts to the atmosphere through stacks or vents.

For those processes with pollution potential, controls are incorporated in the process itself wherever possible; treatment methods are utilized in other cases. *While not every plant has yet achieved pollution-free operation, the chemical industry is committed to an aggressive program to achieve that goal.*

The industry has no air pollution control problems unique to it. Its diversity of processes and products result in the need for a correspondingly wide selection of control techniques. The chemical reactivities and odors of many of its airborne wastes require a degree of control that may be greater than needed by many other segments of industry, but the physical nature of its emissions and the control techniques required for their collection do not differ in kind from those representative of industry in general.

The total problem is so great that there is need to assign priorities commensurate with the degree of hazard to our environment and the prospects for achieving the maximum benefits to the community for the available funds.

Basically, environmental management is a community problem, and its costs ultimately fall upon all of society. Social needs are so great and resources relatively so limited that society cannot afford inefficient or extravagant controls not based upon demonstrated needs.

Air pollution is the presence in the ambient air of contaminants in concentrations and for durations that result in unwanted effects. It is not the mere presence of foreign material in the atmosphere, nor even the production of observable effects by that presence. The determining factor is whether the effects so produced are objectionable.

The definition of pollution thus involves value judgments, and what is pollution to one man may not be to another. The soft blue autumn haze that overlies the Great Smokies of eastern Tennessee may be highly prized by the artist; to the surveyor who has difficulty in seeing his targets, that haze is pollution. To the date grower, faced with increasing atmospheric humidity from the encroachment of irrigated fields about his desert groves, even water vapor is pollution, for the effects it produces on his crops are unfavorable.

With many other air contaminants, the level at which the effects they produce are unwanted and hence constitute air pollution will depend upon the uses of which that air is being made.

The activities of man and the processes of nature have been pouring dusts, fumes, gases and vapors into our atmosphere for uncounted millenia. The purity of the air today in wilderness areas is dramatic evidence of its self-purifying power . . . not just its ability to dilute and disperse these pollutants, but to destroy them, to convert them into harmless end products or to transport them to acceptors that can perform this function.

The rate at which these self-purifying processes can remove contaminants from the air increases as their concentration in the air becomes higher. When the concentration of contaminants in the air is thus balanced at levels high enough to produce undesirable consequences, we have air pollution.

In spite of the impressive statistics often cited about the quantities of aerial garbage being thrown into our air, there is little evidence that on a global basis, any contaminant other than carbon dioxide is showing a progressive accumulation in the general atmosphere. Problems arise not so much from the total quantities as from the uneven distribution of emission sources.

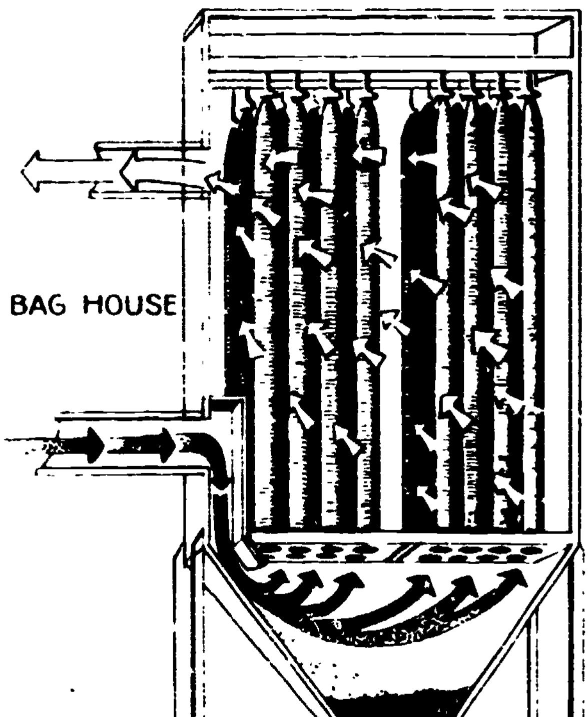
One of the more significant changes in pollution patterns that has resulted from our affluent urban society is the increase in the impact upon the environment of sources related to our personal activities.

Today's city dweller, both by his total number and his residential concentrations, contributes to a vast outpouring of wastes that merge into a sea of contamination that can no longer be identified with a single source, but rather constitutes an effluvium arising from the entire metropolitan area.

METHODS OF CONTROL

Air contaminants can be classified according to their physical properties, that is, whether they are gaseous or particulate, and if they are the latter, whether the particles are solid or liquid, fine or coarse, heavy or light. Techniques and equipment suitable for the removal of contaminants from any emission are determined by such a classification

Solid particulates, both in theory and in practice, are usually the easiest to control To use an analogy that we owe to Dr John Middleton, Commissioner of the National Air Pollution Control Administration—it's much easier to get the olive than the vermouth out of a martini. The filtration of gases for the removal of suspended solids is not always quite that easy. Not only must the filter strain out dust or fume, but it must also be able to resist the temperature and chemical action of the gas stream. It must also have the physical strength and surface properties to permit ready cleaning and removal of the collected dust so that the filter does not become clogged.

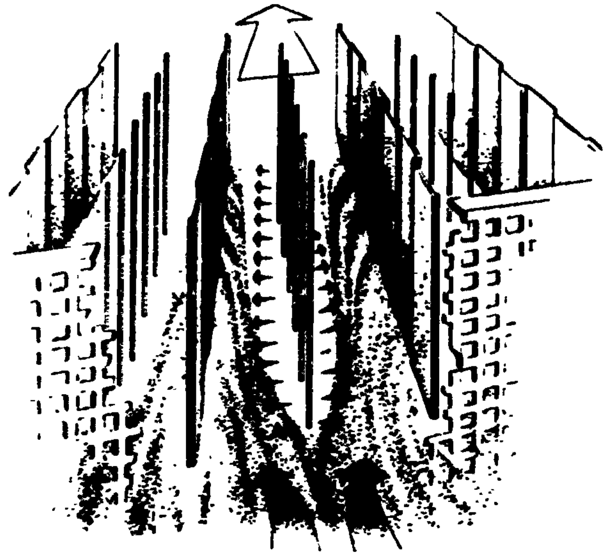


BAG HOUSE

Although many dusts are not suitable for collection by filtration because of their tendencies to cake and thereby clog the filter, the principal problems are economic It is necessary to provide up to one square foot of filter area for every cubic foot per minute of gas flow to be treated The costs of the massive installations, the space they occupy, and the problems of maintenance and bag replacement make this technique practical chiefly where gas volumes are relatively small, and recovery of the dust in clean and uncontaminated form has economic value Otherwise, it is employed only when more economical equipment is unable to do the job.

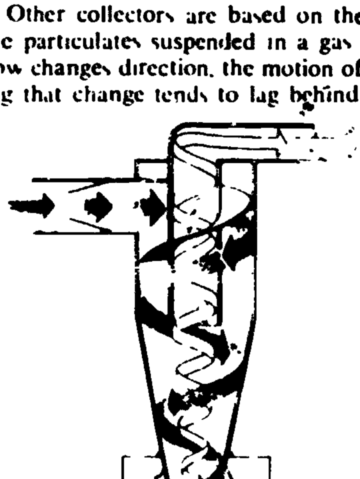
Another technique that has attracted substantial application is electrostatic precipitation. It has merited this attention because of its outstanding ability to collect with high efficiencies many fine dusts and fumes that are otherwise difficult to control. This device places a strong electrical charge on the suspended particulates which are then attracted to and collected on surfaces bearing an electrical charge of opposite sign—in the same manner that the static charge on some synthetic fabrics will attract and hold lint.

ELECTROSTATIC PRECIPITATOR



The dramatic success of properly designed electrostatic precipitators in suitably selected applications should not obscure the fact that there are many kinds of dusts, fumes or mists that are not suitable for this technique. Some emissions create electrically conductive films that short-circuit the high voltages required. Others are so electrically insulating that the first thin layer deposited on the collector plates effectively shields them from further dust collection. And costs may be high.

Other collectors are based on the inertial properties of the particulates suspended in a gas stream. When the gas flow changes direction, the motion of the particle in following that change tends to lag behind so that gas molecules and particulates follow divergent paths. By suitable devices, these path divergencies may be made great enough that the gas may be discharged through one outlet and most of the particles through another The simplest such device is the cyclone, with a cone-shaped chamber. The dust-laden gas enters the chamber tangentially at its widest section and travels spirally downward toward the apex. The dust is removed from the cyclone at the bottom, but the relatively clean gas then



CYCLONE

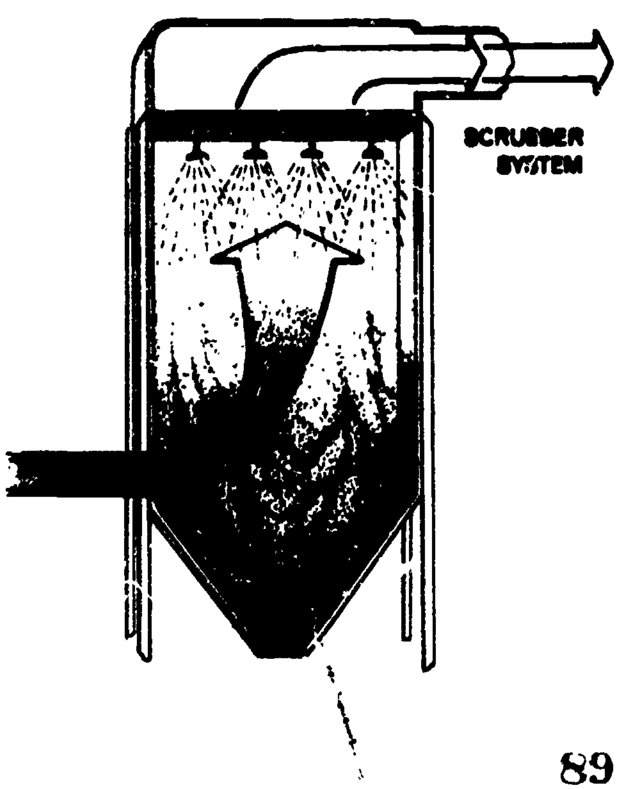
spirals centrally upward in a counter direction and vertically out the top of the cyclone. The spiral path of the gas flow creates a continuous and gradually increasing centrifugal force that tends to carry the particles to the wall of the chamber where they impinge and fall into a collection hopper. The larger and heavier the particle the more easily it is removed from the gas stream. In general, however, it becomes prohibitively difficult to achieve high collection efficiencies with dry inertial collectors on dusts of less than a few microns particle diameter.

When particles are too small to permit ready direct collection by inertial techniques, it is sometimes feasible to impinge them into liquid droplets that are large enough for easy collection. A variety of wet cyclones, venturi scrubbers, and spray chambers have been designed for this purpose.

They are all characterized by the need to put a lot of mechanical work into the process of generating the large liquid surface areas and the high relative velocities of dust particle and droplet required to achieve capture of the particulate matter by the droplets. Their efficiencies as collectors are all closely related to this energy input and, therefore, the power demand and operating cost of high-efficiency devices of this type is substantial.

Wet collectors can be used for liquid mists or sticky dusts that would clog dry collectors. They all produce contaminated scrubber liquors that may present disposal problems.

The removal of contaminants that exist as gases or vapors presents a different set of problems. Ordinarily inertial processes cannot separate these molecules from the bulk of the air flow, and molecular diffusion is far too slow a process to transport them to the solid or liquid surface at which they may be adsorbed, absorbed or chemically reacted. Thus it is necessary to provide for intimate contact between gas stream and absorbent by mechanical means. The wet collectors discussed in the previous paragraph do this, but where gases only are involved, less energy-demanding devices may be adequate. Spray chambers, packed towers, and bubble-plate towers are but a few of the scrubbing devices employed.



Scrubbers for the absorption of gases and vapors are particularly sensitive to the law of diminishing returns. Assume, for example, that for a unit cost we can achieve a 90 percent collection efficiency. To remove 90 percent of the *remaining* contaminant it is not adequate simply to pass the gas stream through a similar purification unit of like kind. The lower tolerances for emission require larger volumes of scrubber liquid, more transfer surface, and longer residence time, resulting typically in a multiplied—rather than merely doubled—collection cost. Still higher collection efficiencies entail exponentially increasing equipment and operating costs.

ECONOMICS OF CONTROL

The selection of the proper design point, to maximize benefit-cost ratio, is of critical importance. Overly stringent standards involve excessive costs with minimal benefits in return. Such excess costs would be much more usefully expended were they devoted to other phases of the environmental management problem.

With the devotion of increased funds and scientific and engineering talents to this problem, improved techniques with greater efficiencies and lowered costs will surely emerge. As the industry continues to grow and diversify, new economic patterns will develop in recognition of the full costs of environmental protection. As we move in that direction, the chemical industry offers its best efforts to achieve an orderly development of rational standards and enforcement policies that will achieve a maximum improvement of the environment with a minimum disruption to the economic health and growth of American industry.

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To the teacher This transparency master supplements this week's American Issues article on pollution. Please see the teaching guide for suggested use

TRANSPARENCY MASTER #JR-203
TO BE USED WITH MAR. 2, 1970 JUNIOR SCHOLASTIC

AIR POLLUTION:

WHERE DOES IT COME FROM? WHAT DOES IT DO?

Air Pollutant	Percent of Total* Pollutants Produced Per Year	Where It Comes From	What It Does to Humans
carbon monoxide	52%	buses, trucks, cars, etc.	Produces headaches, dizziness. Slows reaction time (at heavy traffic levels).
sulfur oxides and nitrogen oxides	18% 6%	industry, incinerators, waste-burning, power plants	Irritate eyes, nose, throat. Produce brown haze that shuts out sunlight, endangers airplane take-offs and landings. Where levels of these oxides are high, levels of lung and throat diseases are high.
hydrocarbons	12%	buses, trucks, cars, etc.	In cigarette smoke, may cause cancer.
particulates	10%	smoke, dust and soot particles in the air	Over the years, some particulates have a slow poisoning effect.
photochemical smog	included among other pollutants	oxides produced when sunlight acts on gases and particles	Makes eyes and throats sting. Makes breathing hard, especially for people who have bronchitis and other lung and throat diseases.

* An estimated 125 to 300 million tons of air pollutants are produced in the U.S.A. yearly. (The 2% not included above are miscellaneous gases.)

Sources: National Academy of Sciences, "Waste Management and Control"; Needed: Clean Air, Channing L. Bete Company

BACKGROUND INFORMATION ON WATER POLLUTION CONTROL

Today there is a public awareness of water pollution which has been stimulated by federal and local legislation. Communication media have dramatically demonstrated the results of water pollution on the environment to the general public. Unfortunately, many misunderstandings and misconceptions have been generated as to the implications of water pollution and water quality on the general well-being of the public.

DEFINITION

Before discussing the implications of water pollution, it is necessary to define pollution. *By one definition, pollution could be defined as anything which enters the water which was not present in its natural state.* It is more realistic, however, to relate pollution to water use. Certainly if the water is to be used for recreational purposes, the presence of trace chemicals such as phenol are neither harmful nor objectionable, while if this same water is to serve as drinking water, these chemicals would cause tastes and odors and must certainly be defined as pollution

In like manner, the presence of nitrogen and phosphorus in agricultural waters for irrigation must be considered an asset; while on the other hand, these same waters discharged into a recreational lake would stimulate the growth of highly objectionable algae. In the latter case, nitrogen and phosphorus are pollutants in every sense of the word; while in the former, they are highly desirable.

We must, therefore, define pollution relative to the intended use of the water. The following table summarizes the principal pollutants relative to water use:

WATER USE	POLLUTANTS
Drinking	Pathogenic bacteria, viruses, taste and odor causing chemicals, color and turbidity.
Recreational	Pathogenic bacteria, floating oils, grease and solids, turbidity, high acidity, algal growths, high organic concentration.
Agricultural	High salt content, high acidity.
Industrial	Depends on quality requirements and water use by industry.

The four classifications shown in the table are commonly used to define water use and have quite different quality requirements. Obviously in many rivers and water courses, there is multiple use of water and under these conditions the highest quality requirement must prevail. An example might be a lake which serves recreational, hydro-electric power and water supply uses. The quality requirements would reflect that required for water supply.

CAUSE

By far the greatest source of pollution comes from organics present in municipal sewage and many industrial wastewaters. When these organic wastes are discharged into a stream, bacteria and other microorganisms naturally present oxidize them which in turn depletes the oxygen resources of the stream. If we consider that the maximum concentration of oxygen which will dissolve in a stream is of the order of 7-9 milligrams liter and that fish life will be adversely affected at oxygen concentrations less than 3-4 milligrams/liter relatively small quantities of organic wastes or sewage can be discharged untreated to a small stream without adversely affecting aquatic life. When large quantities of untreated sewage or waste are discharged to a stream which completely depletes the oxygen, septic and noxious conditions result which are typically characterized by a black appearance and the rotten egg, hydrogen sulfide, odor

We now must consider how much waste can be discharged to a stream without causing a problem. Oxygen is available in the stream water from that present upstream from the waste discharge and that which enters the water by natural aeration. Oxygen is depleted proportionally to the quantity of organics present in the waste discharged. Just as in a bank where the withdrawals cannot exceed the deposits, we can calculate how much wastewater the stream can assimilate. Depending upon the quantity of waste being discharged to the stream, this in turn tells us how much treatment or removal of organics prior to the discharge is required This is a simplification of the procedure being employed today by engineers of federal and state agencies to ascertain what degree of waste treatment is required to maintain the quality of our water courses

As shown in the table, there are many other pollutants which depend primarily on water use *While we can broadly define the parameters of pollution, there are still many unknowns requiring extensive research by governmental, educational and industrial research teams.* The specific identification of water impurities relative to public health and industrial and municipal water uses requires extensive study, particularly with respect to long-term effects New and improved methods of treatment, particularly of the complex industrial wastewaters, are essential if we are to attain long-term goals of pollution abatement with reasonable economy. It should be recognized at this point that municipal sewage may differ quite markedly from industrial wastewaters and require entirely different methods of treatment While effective methods of treatment for sewage are now available, considerable research is necessary to develop effective treatment methods for some of the more complex industrial wastewaters.

REQUIRED ACTION

If we can define pollution relative to water use, the next step is to determine what action must be taken to eliminate the pollution. This phase of the problem necessarily involves the development of standards and criteria. From economic considerations alone the objective of water pollution control should be related to the national income or economic efficiency of our society. *This would mean that any action taken would depend upon a favorable cost-benefit ratio.* This implies that expenditures for wastewater treatment would be reflected in an increased income either nationally or to the region under consideration.

Alternatively, we can adopt standards based on establishing and maintaining a specified degree of environmental quality, quite independent of the economic benefits derived from the pollution abatement measures. In order to illustrate the point, let us take the Hudson River as an example. It is quite apparent that if we accept the first criteria, that is a favorable cost-benefit ratio, the Hudson River would remain a highly polluted water course since the cost involved in developing and maintaining a high degree of water quality is many times in excess of the tangible economic benefits which could be derived. We then consider environmental quality; where, as a wealthy society, we wish to maintain a reasonably high level of water quality irrespective of the cost The primary question today is what level of quality will be acceptable. It is apparent that quality levels must differ in various water courses dependent both on the intended water use, which is an economic consideration, and on the desired water quality which may, in some cases, be primarily an aesthetic or sociological consideration.

Before leaving this point, there is one other important consideration. It may be possible to attain a desired level of water quality today in an urban area such as the Delaware Valley or Houston, Texas by the installation of primary and secondary treatment facilities. If we project, however, urban and industrial expansion in these areas to say—the year 2000—we find that to merely maintain the water quality objectives established today will require tertiary treatment of a very high degree To put numbers to this, maintaining the water quality today may require 90 per cent removal of pollutants.

If industrial and population expansion by the year 2000 increases the total wastewater discharge by a factor of 10, then 99 per cent treatment would be required to maintain the same water quality

Translated into economic terms, 90 per cent treatment for 10 million gallons per day of wastewater will cost $25 million. (It should be recognized, of course, that these figures are based on today's technology and that continuing research into improved methods of wastewater treatment could reduce this cost.)

When we consider the potential order of magnitude of these costs, wastewater treatment becomes an important economic consideration in regional and urban planning, particularly with respect to industrial plant location and expansion. Having established the problem, we next might consider what is being done to solve it.

ACHIEVEMENTS

Over the past five years several federal and private programs have been initiated to study the water pollution problem in the United States, to develop alternate plans of establishing and maintaining water quality, to determine standards and criteria of water quality and to initiate research into new methods of wastewater treatment and improvement of existing methods.

To achieve these objectives a comprehensive national study is being made under the direction of Professor George Reid of the University of Oklahoma to compare the economics of constructing reservoirs and impoundments to provide dilution water during periods of low stream flow with increased construction of wastewater treatment facilities.

Comprehensive studies have been and are being conducted on major drainage areas and waterways such as the Hudson River, the Delaware Estuary and Galveston Bay in order to establish reasonable water quality standards There are over 30 agencies of the federal government actively engaged in the water resources area and each state has one or more agencies investigating regional and local problems.

The federal government has 13 regional laboratories staffed with over 900 engineers and scientists with an expenditure of $10-$15 million per year investigating water pollution control problems. Federal support to private organizations and industry for research and development has surpassed $50 million per year. Over $5 billion has been expended in the construction of wastewater treatment facilities.

Entirely apart from the federal activity in the water pollution control area, industry itself has spent considerable sums of money in both research into new and improved methods of waste treatment and in the construction of wastewater treatment facilities. In many cases these expenditures have reflected civic responsibility rather than political expediency. In the chemical industry alone, the investment in wastewater treatment facilities to date exceeds half a billion dollars. An annual expenditure of over $9 million on research and development is directed toward establishing new and improved methods of waste treatment.

TRAINING

One of the most critical problems in achieving effective water pollution control is the lack of trained technical personnel.

Until only a few years ago less than 250 sanitary engineers were graduated annually in the United States. In 1966, the graduates totalled 500 with projections of 1,000 by 1970.

Even these increased numbers of graduates will not meet the rapidly increasing technical needs of the field. In order to provide needed present technology, short courses are provided by the federal government, universities and other groups for engineers and scientists.

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COMMON SOLID WASTE DISPOSAL METHODS

METHOD	DESCRIPTION	DIRECT COST A	DIRECT COST B	STATUS
mechanical compaction	compression of refuse to reduce its volume by a ratio of 3 - 15	....	..	used extensively to reduce collection and hauling costs
burning and dumping in the open	dumping and burning of refuse in the city dump	minimal	..	accounts for 45% of waste disposal, but use is decreasing
incineration	burning of refuse in a furnace under controlled conditions	3,000-10,000	3 - 8	fairly accepted in large communities
pyrolysis	chemical conversion of organic fractions to useful products	5,000-10,000	3 - 10	introduction contingent on salability of products
composting	conversion of organic fraction to harmless products by microbial activity	4,000-10,000	3 - 10	introduction contingent on salability of products
sanitary landfill	burial of refuse or processed residue under 1 - 2 feet of soil	1,000-2,000	1 - 2	accounts for 45% of waste disposal, especially in communitieswith access to land expanses
mine fill	hauling of refuse to and burial in abandoned mines	....	4 - 6	being introduced in large communities with access to abandoned mines
ocean dumping	dumping of refuse from barges into open ocean	....	..	largely discontinued, except for a few coastal cities

A - capital investment, in $ per ton of rated daily capacity B - operating cost, in $ per ton of unprocessed refuse

COMMON SOLID WASTE DISPOSAL METHODS (cont'd)

METHOD	DESCRIPTION	A	B	STATUS
hog feeding	feeding garbage to hogs	not relevant		largely discontinued as a consequence of sterilization requirement
waste disposer	grinding of garbage in sink unit and disposal in sewers	not relevant		fairly popular in communities with sewer systems
salvage	processing and re - use of waste	highly variable		ancient, with a growing impact

A - capital investment, in $ per ton of rated daily capacity

B - operating cost, $ per ton of unprocessed refuse

data taken from:
Hershcft, "Solid Waste Treatment", <u>Science and Technology</u>
June, 1969. #90. pp.34 - 42

Filter Media

Carborundum Air Pollution Control
Condensed Catalog

Fabric Filters for All Dust Collectors

Carborundum introduced Ironclad® filter media in 1968 . . . and foundries, cement plants, stone quarries and numerous other industries have reduced the cost of filter media replacement in their pollution control systems by as much as 50% ev' ; since.

Ironclad filter media costs about one-third more than cotton but lasts about three times as long. This results in impressive savings almost everywhere this new filter media is now being used.

The development of Ironclad is only one example of Carborundum's new leadership in filter media technology and cost reduction in the pollution control field

Through its Pollution Control Division, The Carborundum Company offers bags and tubes of virtually every material currently in use, for every fabric filter dust collector regardless of type or make.

This includes a complete range of engineered fabrics for high temperature applications—cement kilns, electric furnaces, scarf:ng operations, sand smelters and many others.

Higher Efficiency, Lower Cost

Innovation, plus a unique capability to apply the correct filter in the fabric construction best suited to your special problem, is the special talent of Carborundum. Higher efficiency or lower cost (and ~~sometimes~~ both) result.

Example: Specially designed wool ·. system fabrics are now increasing efficiency in dust collectors which use shaker cleaning methods. We offer a complete line of natural and synthetic fibers in these woolen system fabrics.

Example: Specialty fabric Style 0772 has doubled filter life at a large chemical plant in the East.

Example: Style 1205 permits high air-to-cloth ratios while maintaining efficient ventilation—and therefore is used to increase collector capacity

Example: Style 1201 offers unusual abrasion resistance and low electric resistivity, solves dust release problems caused by static electricity

Example: A new hybrid felt engineered by Carborundum to increase the wear life of felt tubes used for control of abrasive dust.

Example: Bag/tube suspension innovation—sewn-in hanger devices to reduce turn-around time in reclothing your dust collector.

Fabrication Techniques

Carborundum now produces filter tubes with no vertical seam stitching. This new method of fabrication—a development of its Filter Media Products engineers—provides a true cylinder to clothe support cage.

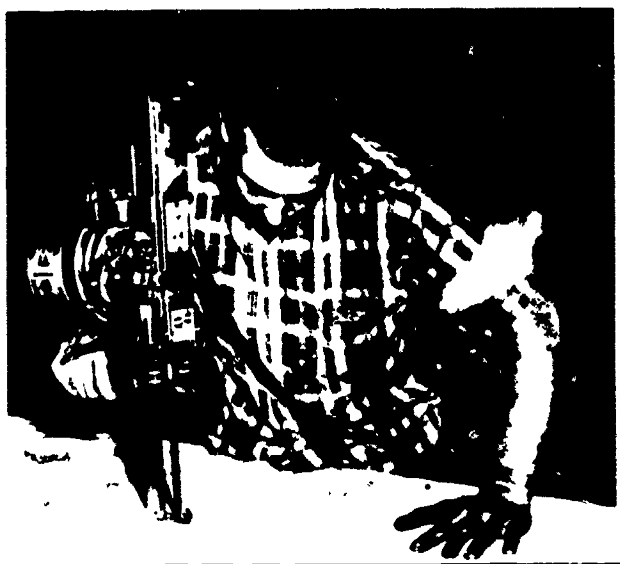
The method also provides superior seam flex characteristics, and because there are no needle holes, dust seepage is eliminated.

Fiberglass Fabric

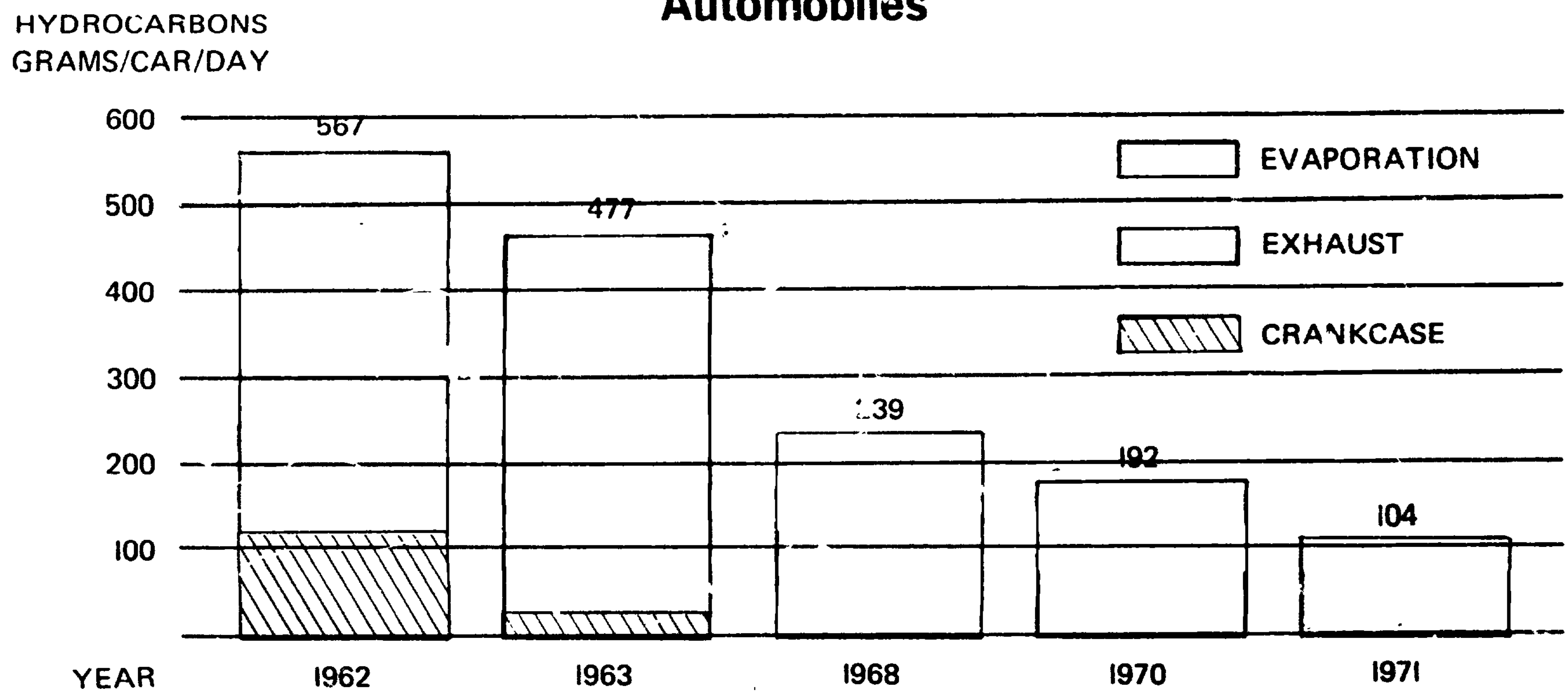
Filter Media Products. The Carborundum Company. has achieved a leadership position in replacement of filament and bulked fiberglass fabrics for all types and makes of dust collectors

In 1969 this branch introduced a new concept in fiberglass filtration fabrics Style 0004 is an exceptionally well balanced fabric with long flex life. The high percentage of bulked yarns allows longer intervals between cleaning cycles while maintaining lower resistances in the total system

By combining better balance in the wear life of warp and fill and extending the time between cleaning cycles, Style 0004 has proved its ability to perform better and last longer than fiberglass media supplied by other companies. This has been particularly true in carbon black applications but the new fabric is also performing well in all other appropriate applications.

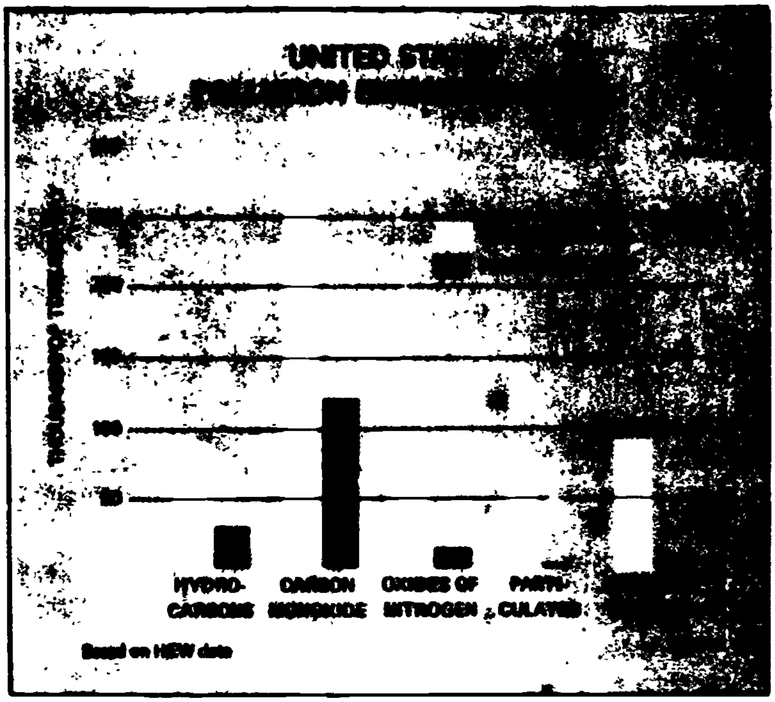


EFFECT OF CONTROLS ON HYDROCARBON EMISSIONS
Automobiles

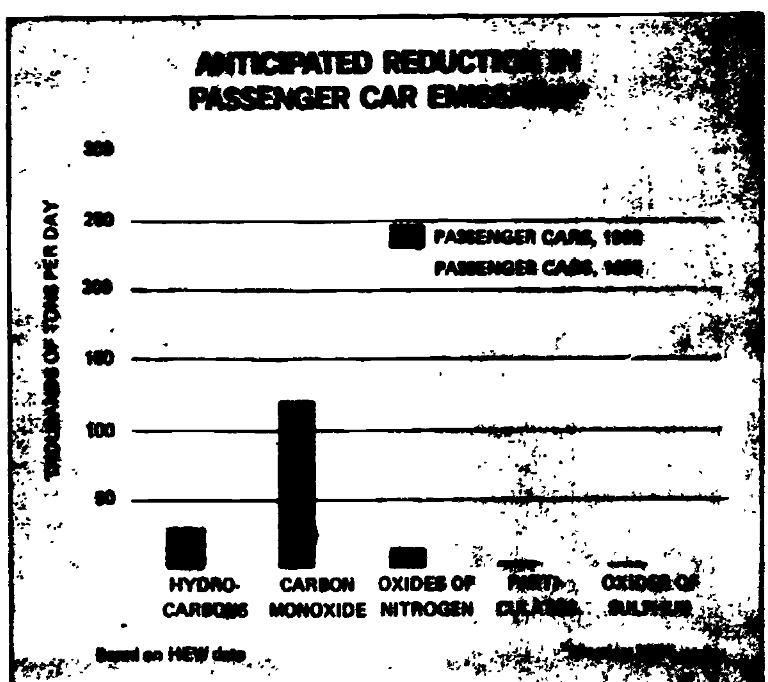


THE AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

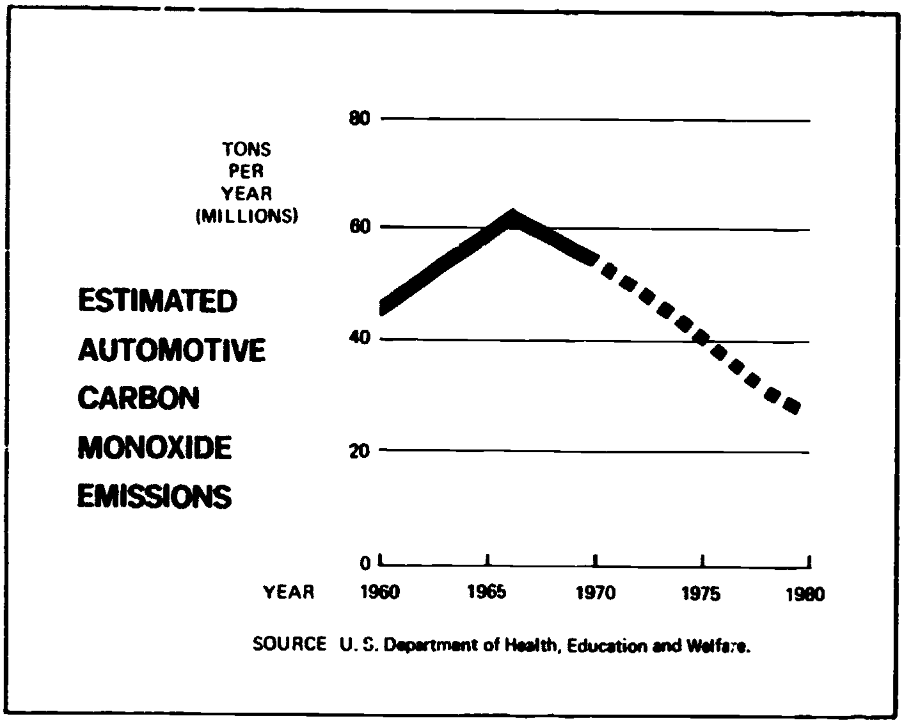
Hydrocarbons, one of the major elements in vehicle emissions, continue to decline as automotive engineers develop more effective controls. Based on current test procedures hydrocarbon emissions from 1971 cars have been reduced 80 percent over 1962 and earlier models.



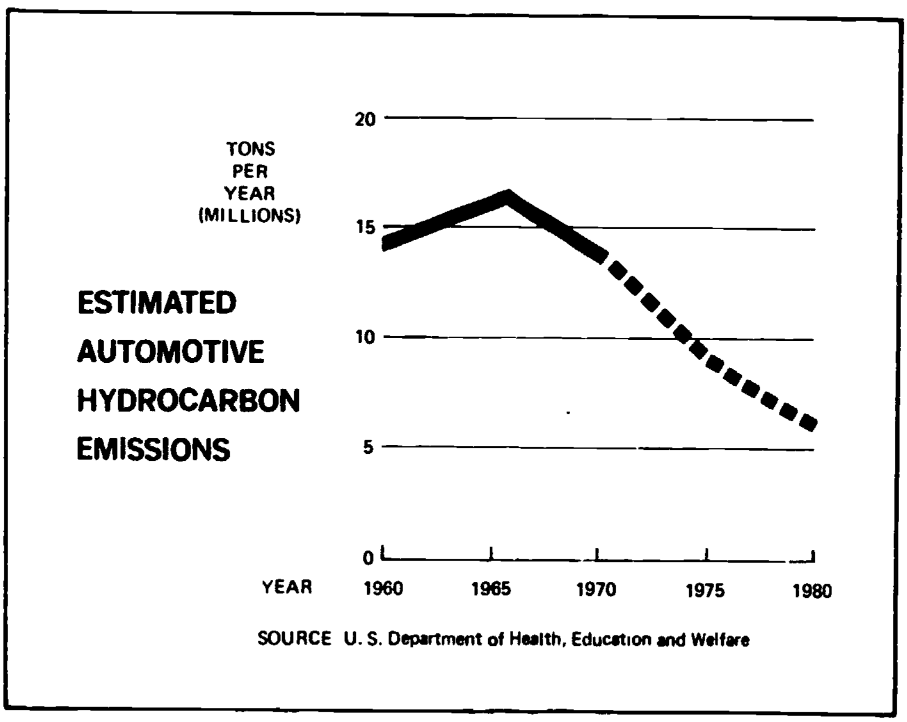
The automobile's role in air pollution is shown in this chart which compares the weight of pollutants from cars with that of all sources.



America's motor vehicle manufacturers expect to achieve even greater reductions in various elements that comprise automobile emissions. Chart indicates percentage reduction required by standards proposed for 1975 in February, 1970.



Carbon monoxide emissions already have been reduced 65 percent. By the early 1980's, all carbon monoxide emissions will be lowered to the same as that existing 30 years before.



The full effect of current pollution control systems on motor vehicles will be realized in approximately ten years when cars without controls will have been replaced.

The System

Carborundum Air Pollution Control Condensed Catalog

An air pollution control system consists of five primary parts.

Exhaust hoods, canopies, piping and ductwork that capture the dust and fume and transport it to the control equipment. This important part of the system can often be fabricated locally, but the design and layout should be handled by engineers experienced with air quality problems.

Air pumps, fans and drive equipment move the air through the piping and ductwork to the control equipment. Size, type, and location of this part of the system is determined by study of the specific conditions and experience in application

Dust or fume collector. Selection of the proper type, size, location and maintenance are the factors which determine both the efficiency of the system and its final operating costs.

Filter media Should be selected by an experienced air quality engineer who has studied the problem and has working knowledge of all the fabrics, weaves, and finishes available. Without the proper filter media the finest equipment will fail to provide the required control . . . . . or provide it only at excessive cost.

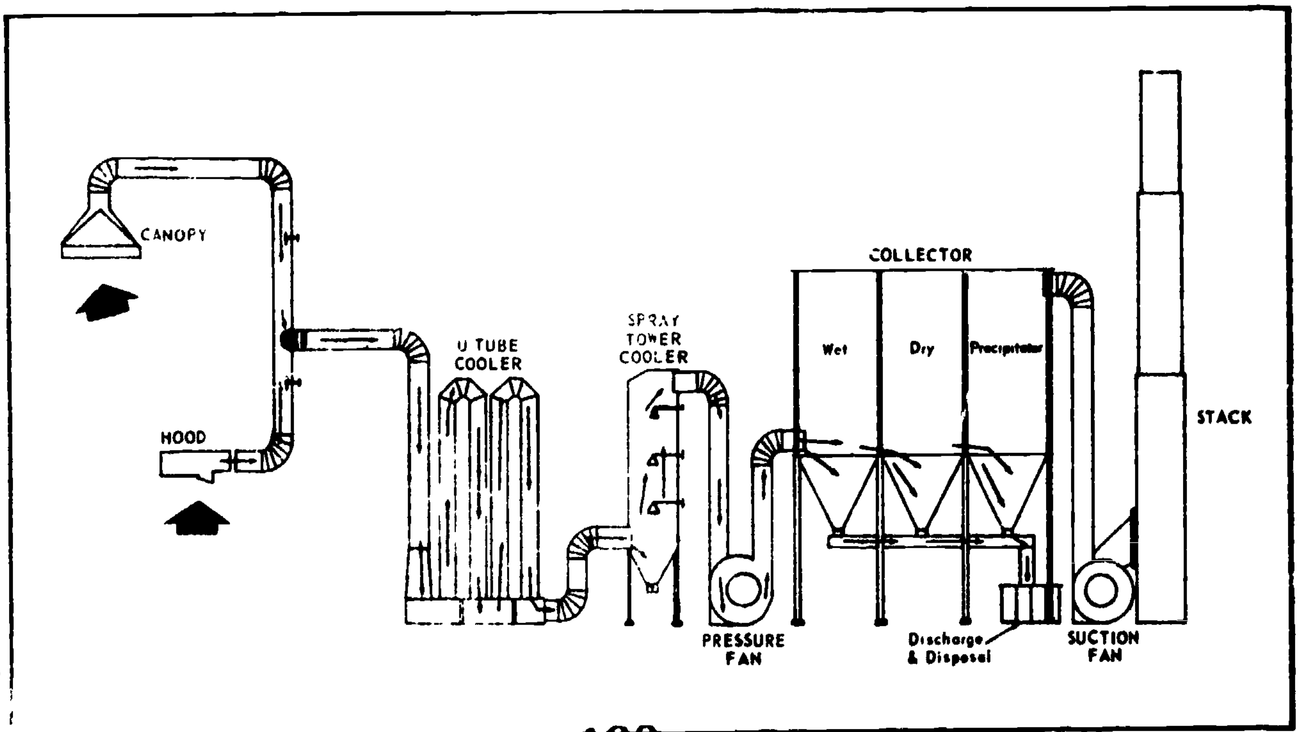
Discharge and disposal equipment. After contaminant or dust has been removed from the air stream it can present a problem unless disposal has been engineered into the system. Most of the material recovered is fine particulate matter and the least expensive method of disposal is to truck it to a local dump site. But if the material collected has commercial value, a method of recycling or packaging should be designed into the system.

Bulk handling of fine particulate matter can cause problems, so some systems include pelletizing equipment Wet collectors create slurry and sludge which must be treated to avoid creating a water pollution problem.

You should rely on an experienced pollution control engineer to help select a final disposal method to suit your specific requirements.

A properly engineered pollution control system can be a profitable investment. Anything less is simply an expense.

Carborundum specializes in properly engineered systems.



Carborundum Air Pollution Control
Condensed Catalog

Pangborn Type CH-3 Self-Cleaning Collector

Features

Se'f cleaning.
Continuous operation.
Compactness of cloth cleaning mechanism.
High collection efficiency.
Cloth screen filter media.
Low maintenance and downtime.
Unit type construction.

The Pangborn CH-3 dust collector is best applied where dry flowable dust is encountered and the space available for a collector is limited.

A reverse air manifold on the clean air side is used to blow the entrained dust from the filter screens. The dust is allowed to fall into the hopper. The manifold moves from filter screen to filter screen in a continuous cycle, cleaning all the media. Since only one row of filter screens is cleaned at a time, the rest of the collector is unaffected and continues to clean the air. The entire collector self-cleans and runs continuously, eliminating the need to shut down for cloth cleaning.

For additional information write for Bulletin 923.

Diagram of Action of Cloth Screen Collector

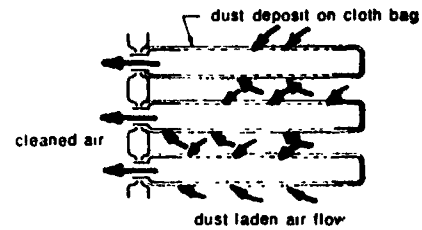
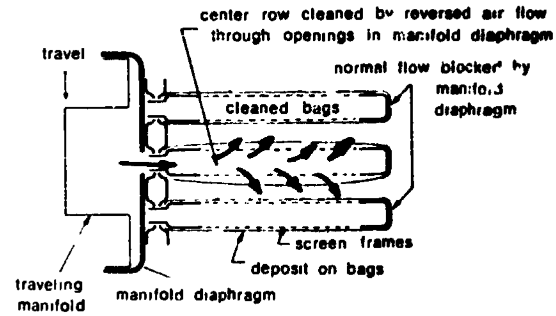
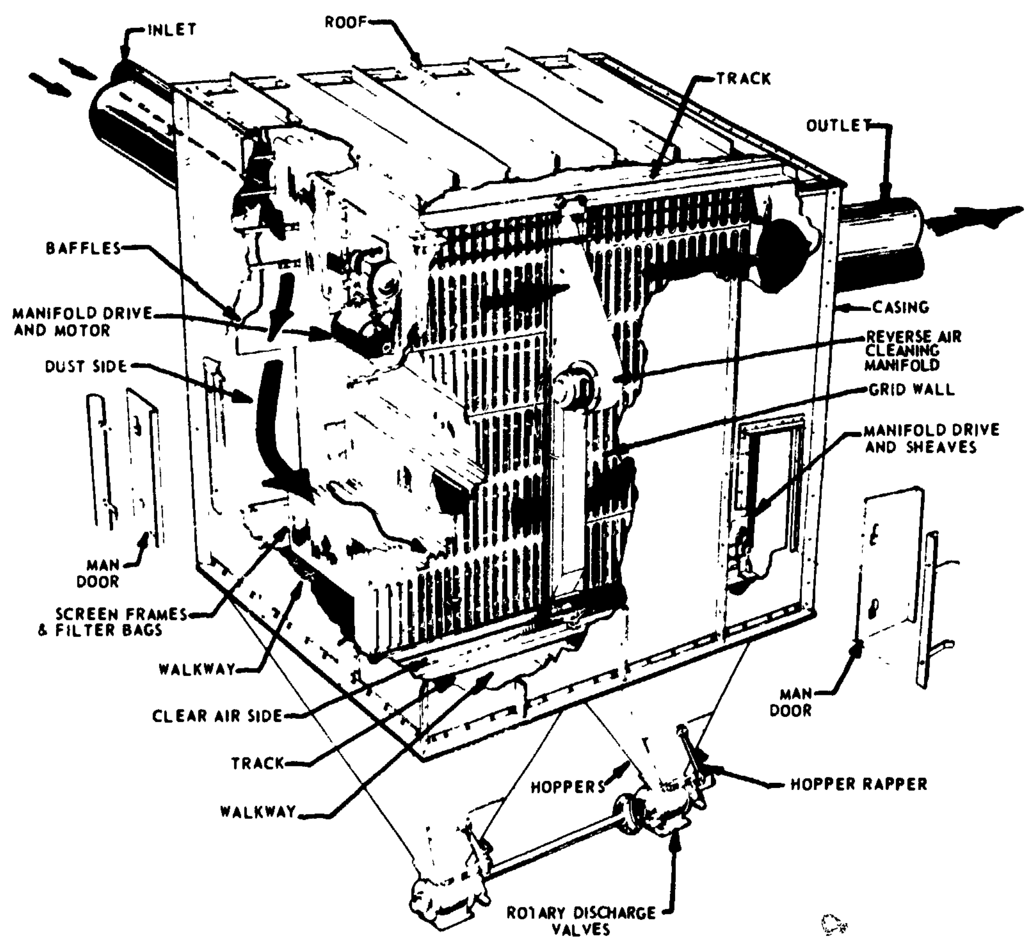


Diagram of Cleaning Action of Manifold





Pangborn Type CO Dust Collector

Features

Pressure-Jet reverse air cleaning.

Continuous automatic operation.

Long dust tube life.

Low maintenance. (All moving parts are accessible from outside the collector.)

Existing reverse air collectors can be converted to Type CO

Multiple compartment construction.

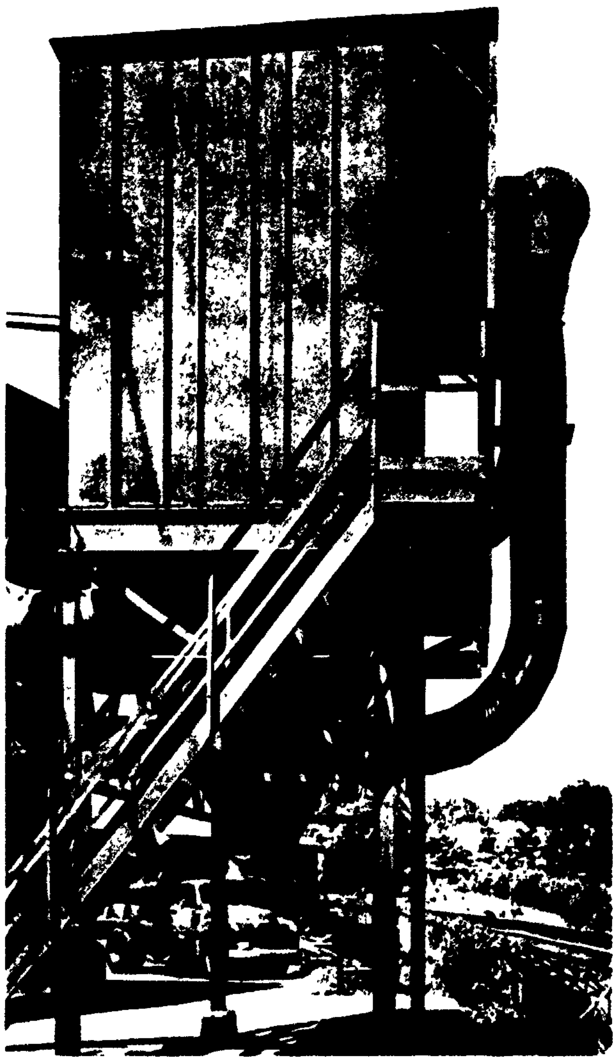
Design and operation of this dust collector is simple The gas inlet is located below the filter compartment so the heavy particles drop directly into the storage hoppers Dust is collected inside the fabric tubes as the gas is forced through the filters to the main compartment from which it is exhausted.

Pressure-Jet filter cleaning restores the filter surfaces to like-new effectiveness. In the Pressure-Jet method, developed especially for synthetic fabrics, positive pressure is alternated with negative reverse pressure to create a pulsating action in the filter tubes. A simple jet inside each filter tube provides short puffs of higher pressure air alternating with a small amount of reverse air flow from the main fan. This action partially relaxes the tubes and effectively removes the collected material from the filter surfaces. The intensity of the cleaning action can be varied from a slight pulsation to the equivalent of mechanical shaking

Completely automatic, the CO collector is controlled by an electric program timer which can be preset to suit specific requirements Multiple compartment construction and a range of larger tube sizes make this control system extremely versatile and adaptable to diversified applications.

For additional information write for Bulletin 2341.

Pangborn Type CO Dust Collector featuring pressure jet cleaning.



Pangborn Posi-Pulse High Ratio Collector

Features

1. World's first 100% fluidic controlled dust collector.
2. Completely self-contained units.
3. Medium pressure, oil-free air pumps.
4. Fluidic controls.
5. Full volume reverse air cleaning.
6. Inherently explosion proof.
7. No electrical controls required.

Posi-Pulse Systems

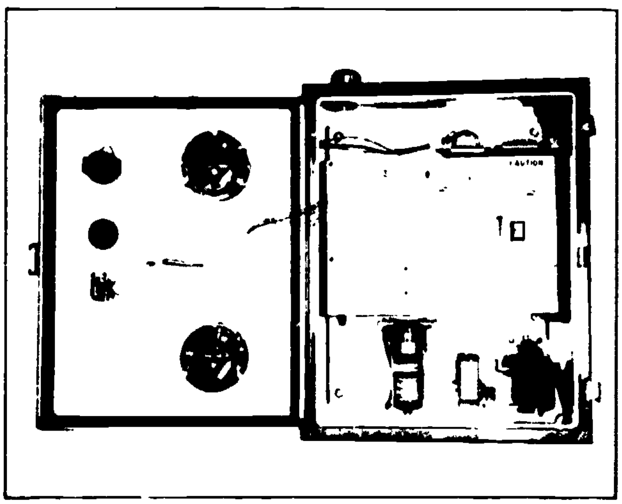
The Pangborn Posi-Pulse is a highly advanced design of present models of the jet type, high ratio dust collector.

Proper filter cleaning in high ratio collectors is essential and in this collector is attained by using low pressure reverse air.

The new Posi-Pulse design uses a patented valve which discharges the full air volume required for proper cleaning into the bags. This exclusive design obtains equal bag cleaning impact with far less air pressure—in the 8 to 1[illegible] psi range.

The medium air pressure requirements of this design can be supplied by "oil free" air pumps which eliminate the need for high pressure air from piston type compressors. This lower pressure air tends to eliminate conditions where condensation will occur and results in a dryer filter element which works better and lasts longer

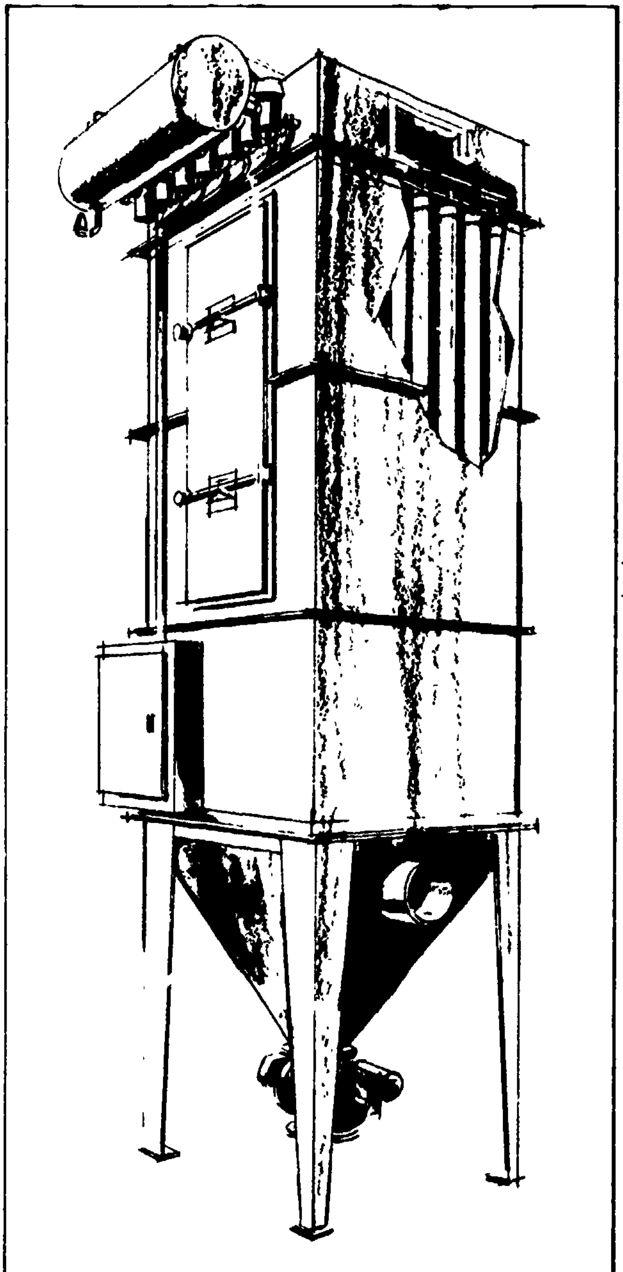
The Fluidic Panel—controls sequencing and timing of the valves in the bag cleaning system—no electrical hazard—no moving parts.



The medium pressure reverse air used with the Pangborn design does not shock the bags to attain release of the dust cake. Instead the dust cake, which is collected on the outside surface of the felt tube, is removed by air reversal so the strain on the bags is greatly reduced. This gives you substantial increase in bag life and lower media costs over the years.

The Posi-Pulse collector is available in more than 75 standard models of three basic types, with capacity ranges from less than 100 CFM to more than 100,000 CFM. A full range of filter media is available for any application.

For additional information write for Bulletin 935.



Air Pumps

Another Posi-Pulse plus is the "oil free" air pump. This system of rotary air pumps provides "Posi-Pulse" bag cleaning air by positive displacement.

By utilizing medium pressure, a range of 8 to 12 psi for bag cleaning, we eliminate oil and moisture contamination in the cleaning air which would internally foul the bag. Bag contamination due to oil and moisture by condensation is a common problem on systems using higher pressure air from piston type compressors.

Typical cleaning air requirements are an average 1 10 CFM per sq ft of filter media at 10 psi.

All cleaning air pumps are supplied as a base mounted motor driven unit complete with V-belts, pump motor, drive and belt guard. The available accessories include the relief valve, inlet filter, pressure gauge and muffler.

Fluidic Control Systems

The Pangborn Posi-Pulse is using ~~this~~ new advanced fluidic control technology. The system has no moving parts, insuring high reliability. Fluidic controls are operational over a wide range of temperatures. Advantages include low operating air pressure and low air comsumption. The control panel includes displays for valve operation, sequencing and a malfunction detection system. The system uses a plug in the fluidic control module for low maintenance and easy servicing

Air operated Posi Pulse valve combines extremely quick release with dependable construction and simplicity

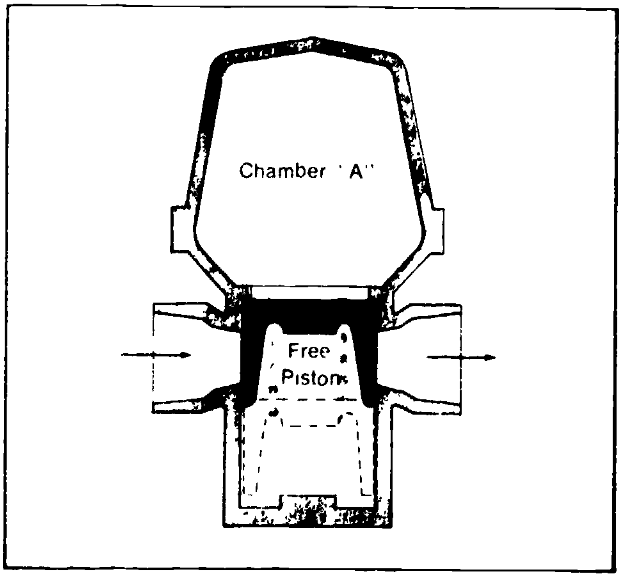
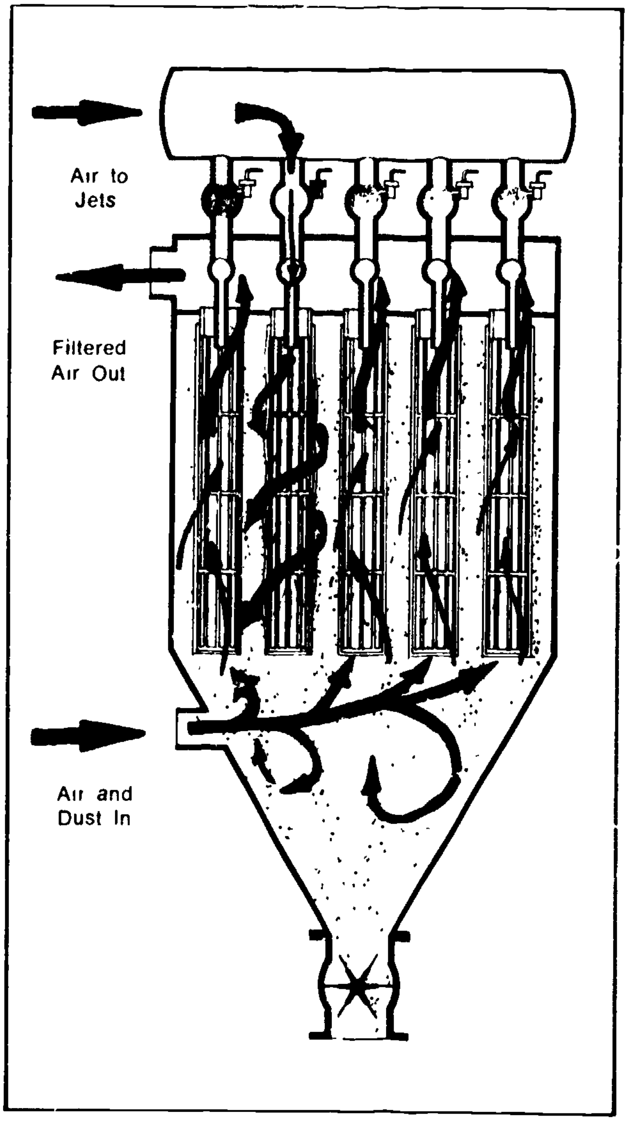


Diagram illustrating the exclusive Posi-Pulse principle. Note that the air released through the open jet valve provides reverse flow volume and impact as it discharges. The pressure drops in the tank. When the air tank again sends its "full" pressure signal to the fluidic panel, the adjacent valve fires.



Pangborn Unit Type CN

Features

All Pangborn Type CN dust collectors, are now supplied with Ironclad filter bags as standard equipment. This is a Carborundum exclusive (See Filter Media section)

Simplified design and construction involves a minimum number of parts.

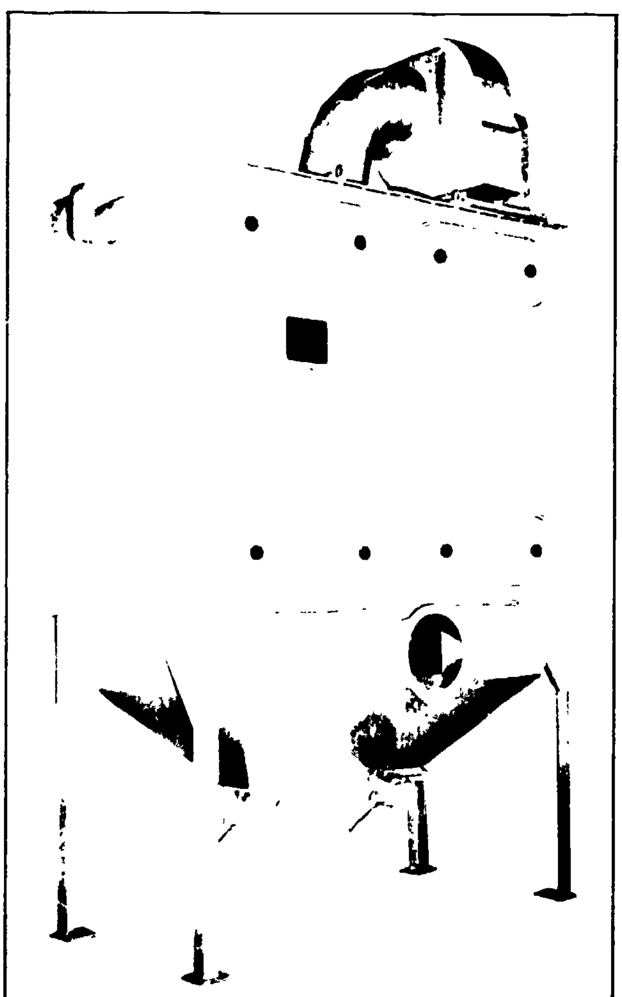
Any bag can be inspected, removed or replaced without disturbing an adjacent bag

Bag design forms large size multiple tubes for adaptation to a wide variety of industrial dusts.

Simplified, effective bag suspension and shaking mechanism has a minimum number of parts.

Economical to buy, install and operate.

The Unit Type CN dust collector was designed to meet the need for an economical, highly efficient dust collector for small volume applications. It is a self-contained unit, ready for installation. Dust is collected in cloth filter bags, an efficient method that makes the CN collector practical and effective for controlling all types of finely divided dry dust.

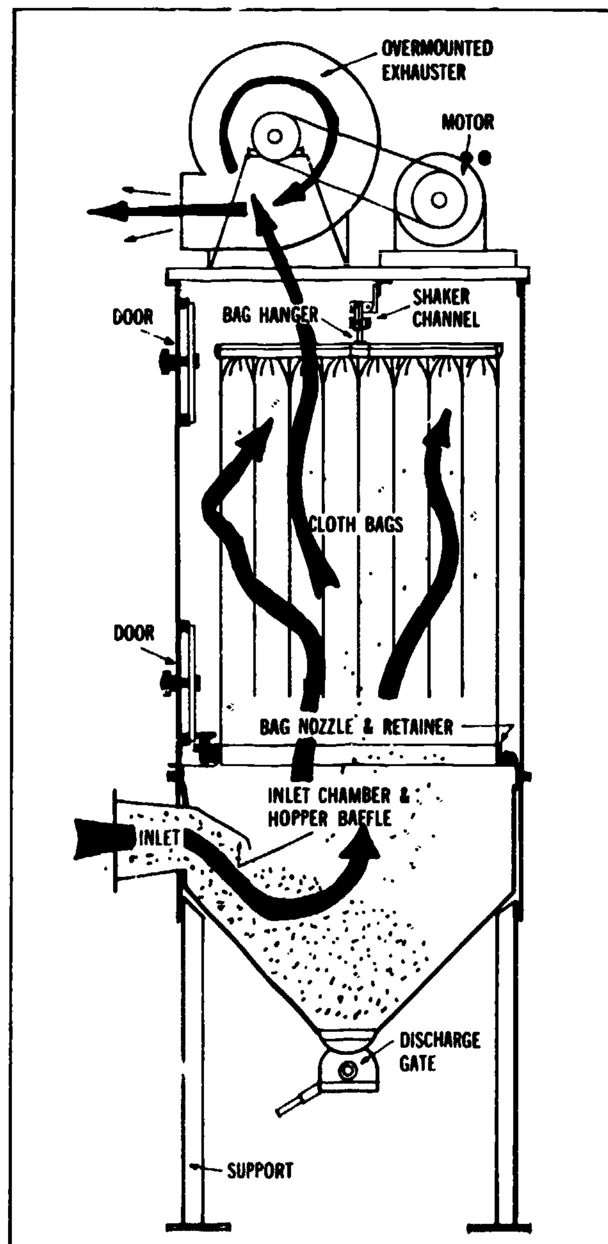


How It Works

The dust laden gas entering the collector passes into the settling chamber, where the reduction in velocity drops coarser dust particles directly to the hopper. A baffle plate aids in this step by preventing the gas from blasting the underside of the cloth bags so that materials of coarse, abrading nature are diverted before reaching the bags. The gas, which still contains fine dust particles, flows into the bags where the dust is filtered on the inner cloth surfaces. The cleaned gas passes through the bags and is discharged from the collector.

CN dust collectors are available in eight sizes, ranging from 200 to 1500 square feet of cloth area.

For additional information write for Bulletin 916A.



Pangborn Type CM Dust Collector

Features

The CM's cloth bag is multi-tube and open at the bottom.

The seams are sewn vertically up the bag forming six tubes, with the common opening at the bottom.

The sponge rubber seal at the bottom affords simple and effective bag sealing.

Large size, unobstructed inlet openings to bags reduce intake velocity and wear on cloth.

Effective, simplified bag suspension and shaking mechanism.

Maximum cloth area per foot of collector casing length.

All bags easily accessible for inspection and maintenance (by a central interior walkway in the collector).

8 Any bag can be inspected, removed or replaced without disturbing adjacent bags, and without use of tools.

9 Unit construction provides flexibility of arrangement.

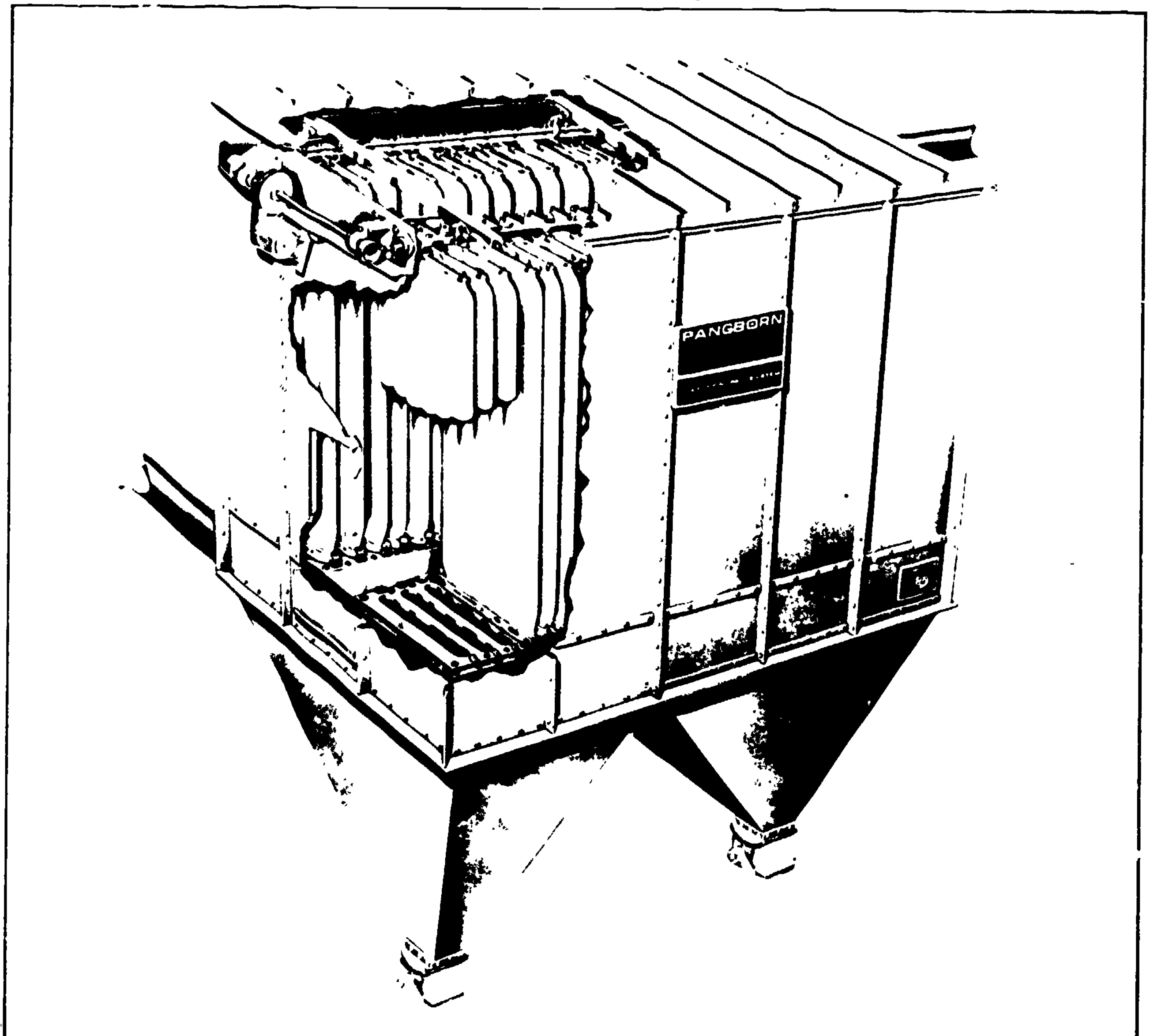
10 Can be compartmented.

The CM dust collector is a modular type, adaptable to a wide variety of industrial dust problems. Unit construction offers the advantage of your being able to increase your system capacity by purchasing additional units.

The CM is constructed of heavy gauge steel. Ease of maintenance makes it an economical solution for most air quality problems.

For additional information on the CM collector, request Bulletin 914A.

Cutaway view of the Pangborn CM cloth bag dust collector shows the large amount of cloth filtering area per foot of casing length.



Pangborn Type CV Ventrijet Dust Collector

Features

- Complete, self-contained wet type unit
- Low head room and minimum floor space requirements.
- Hinged access doors, quick-release type
- Venturi tube design presents a full opening for uniform air flow.
- Straight through tube design and high velocity washing action
- Water make-up is constantly supplied through an adjustable orifice in the water connection
- The water eliminator section is readily accessible for inspection and cleaning
- Ease of installation

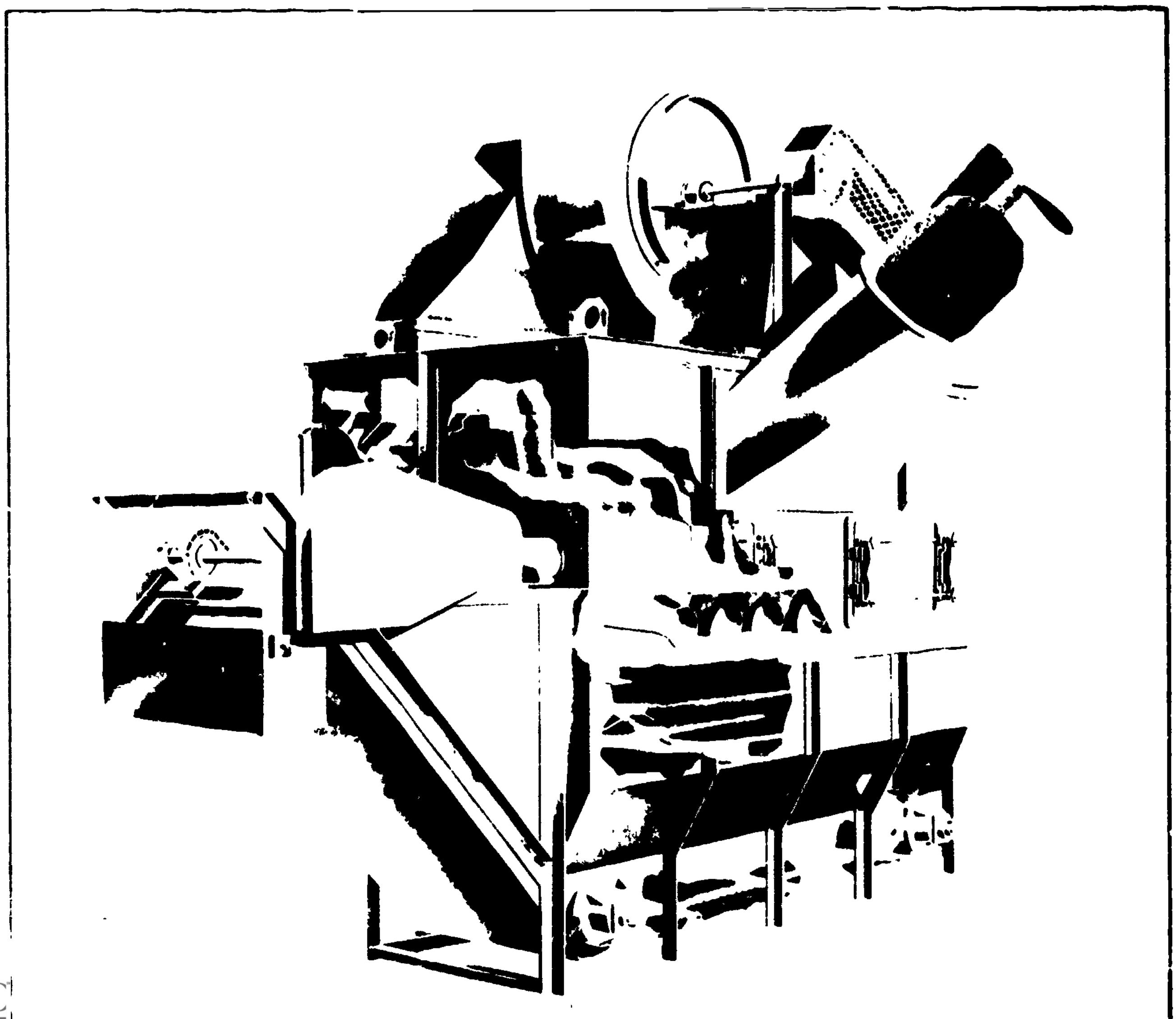
CV Ventrijet Wet Collector

The Pangborn Ventrijet provides efficient wet dust collection. It is particularly suitable for the control of airborne dust in humid and or chemically active gases which are unsuitable for dry cloth collector applications.

As the air flows into the venturi tube, water in the low pressure section of the venturi throat is broken up by the high velocity air stream. Dust particles in the air stream are wetted as they are expelled from the venturi tubes. The particles settle to the bottom of the collector and are removed by a drag conveyor as sludge. Airborne water droplets are removed as they pass through the eliminator section.

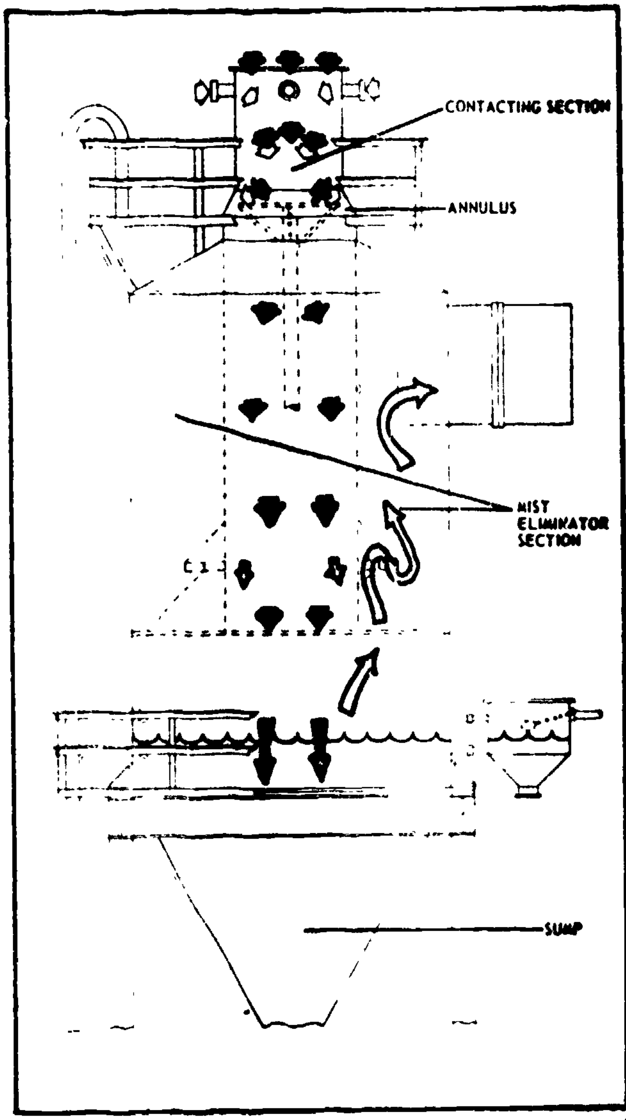
For additional information on wet type dust or fume control, send for Bulletin 920.

This cut-away view shows the arrangement of the venturi tubes and the mechanism by which sludge is conveyed from the collector



CPD Scrubber

CPD Scrubber illustrating mixture of gas and scrubbing liquid.



Features

1 Constant pressure drop.
2 Constant efficiency over a broad range of gas volumes.
3 No nozzles to clog up.
4 Scrubber and mist eliminator are combined into a single piece of equipment.
5 No high pressure water requirements.
6 Construction is uncomplicated and rugged

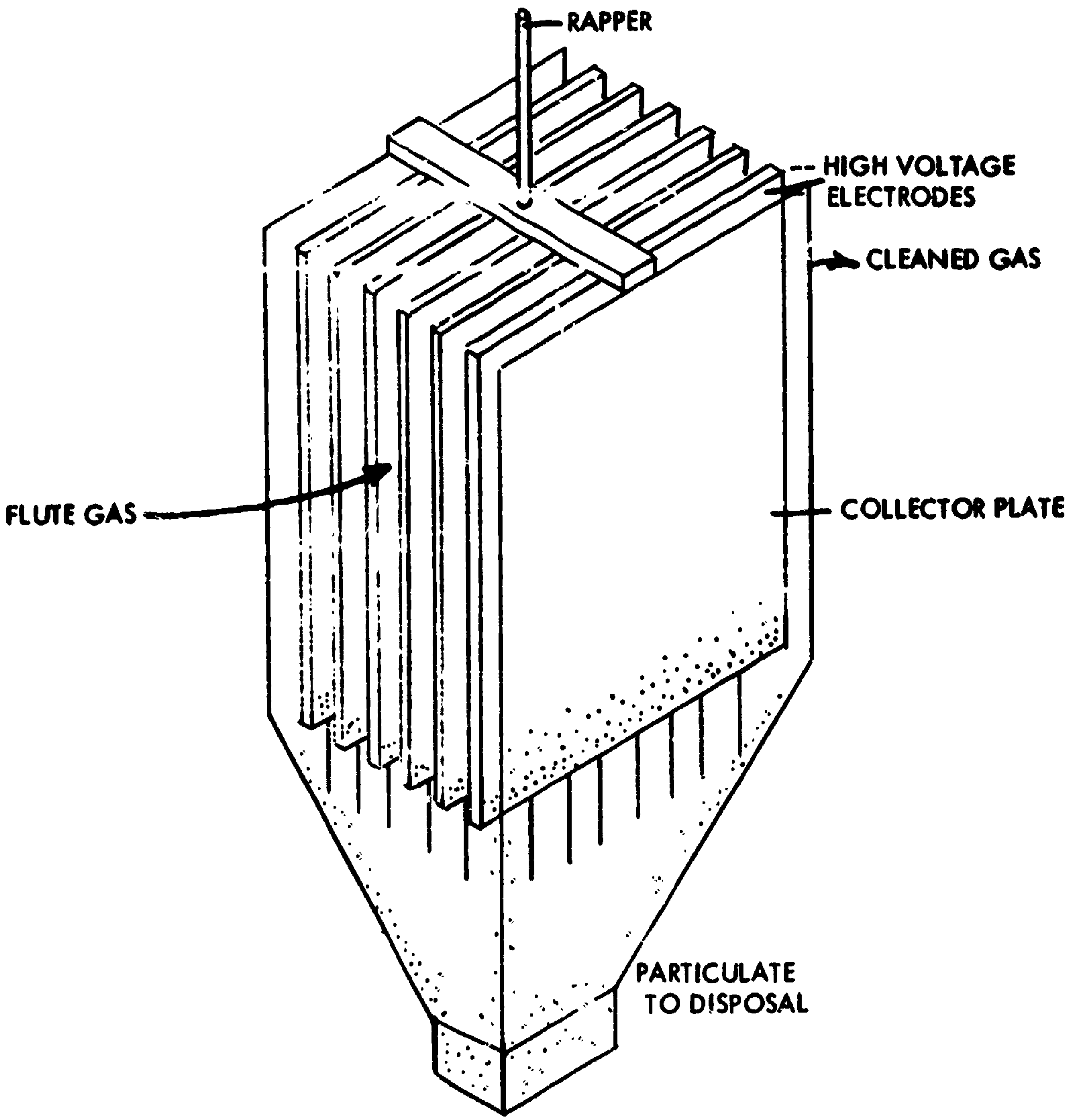
The CPD Scrubber was designed to meet the need for consistent, effective gas cleaning. The unit is highly flexible in its application since it will operate efficiently from 50% to 150% of the design rating.

How It Works

The gas enters the contacting section flowing downwards into the scrubbing liquid zone and through the variable annulus high velocity scrubbing section. A turbulent mixing of the gas and liquid is caused by the high velocity which results in the atomization of the water droplets. This is necessary for the capturing of the dust or fume particles. The collection is impinged on the water surface of the sump in the lower region of the mist eliminator. The gas is then completely freed of water dust droplets by passing through a series of baffles.

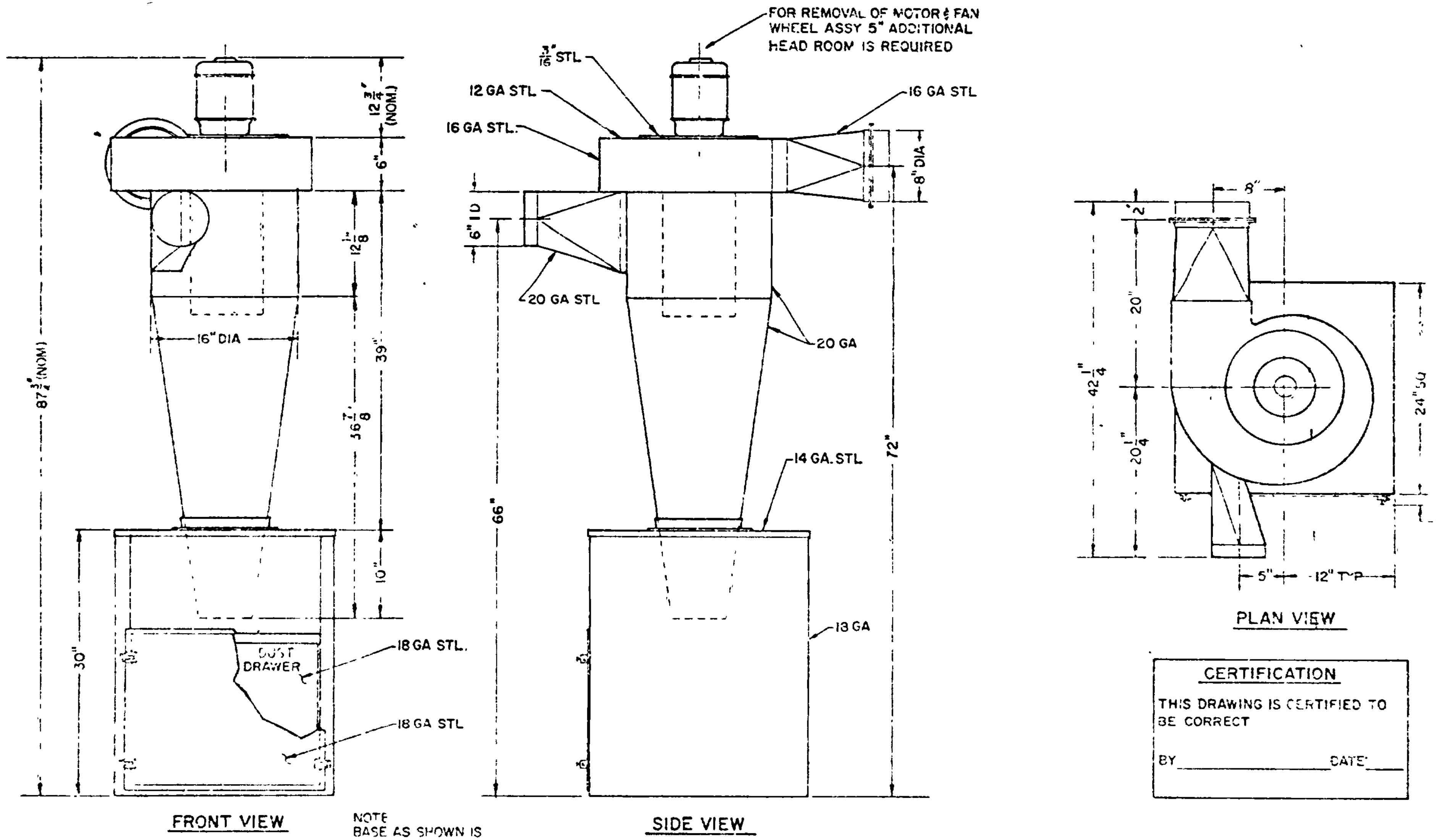
CPD Scrubbers are available in six standard sizes, ranging from 10,000 to 100,000 CFM, larger units can be engineered where required.

For additional information write for CPD product data sheet.



ELECTROSTATIC PRECIPITATOR

After passing through the plant's dust collectors, flue gases flow through electrostatic precipitators, where high-voltage static electricity attracts particles to continually vibrating plates. Ash then drops from plates to collecting hoppers below.



NOTE
BASE AS SHOWN IS 90° CLOCK WISE FROM STANDARD POSITION

CERTIFICATION

THIS DRAWING IS CERTIFIED TO BE CORRECT

BY ______________ DATE ______

MULTIPLE RATING TABLES		
CFM	VELOCITY (FPM)	EXT S P

SPECIFICATIONS

... HP 3600 RPM, 230-460/60/3 ... SHALL HAVE A ...

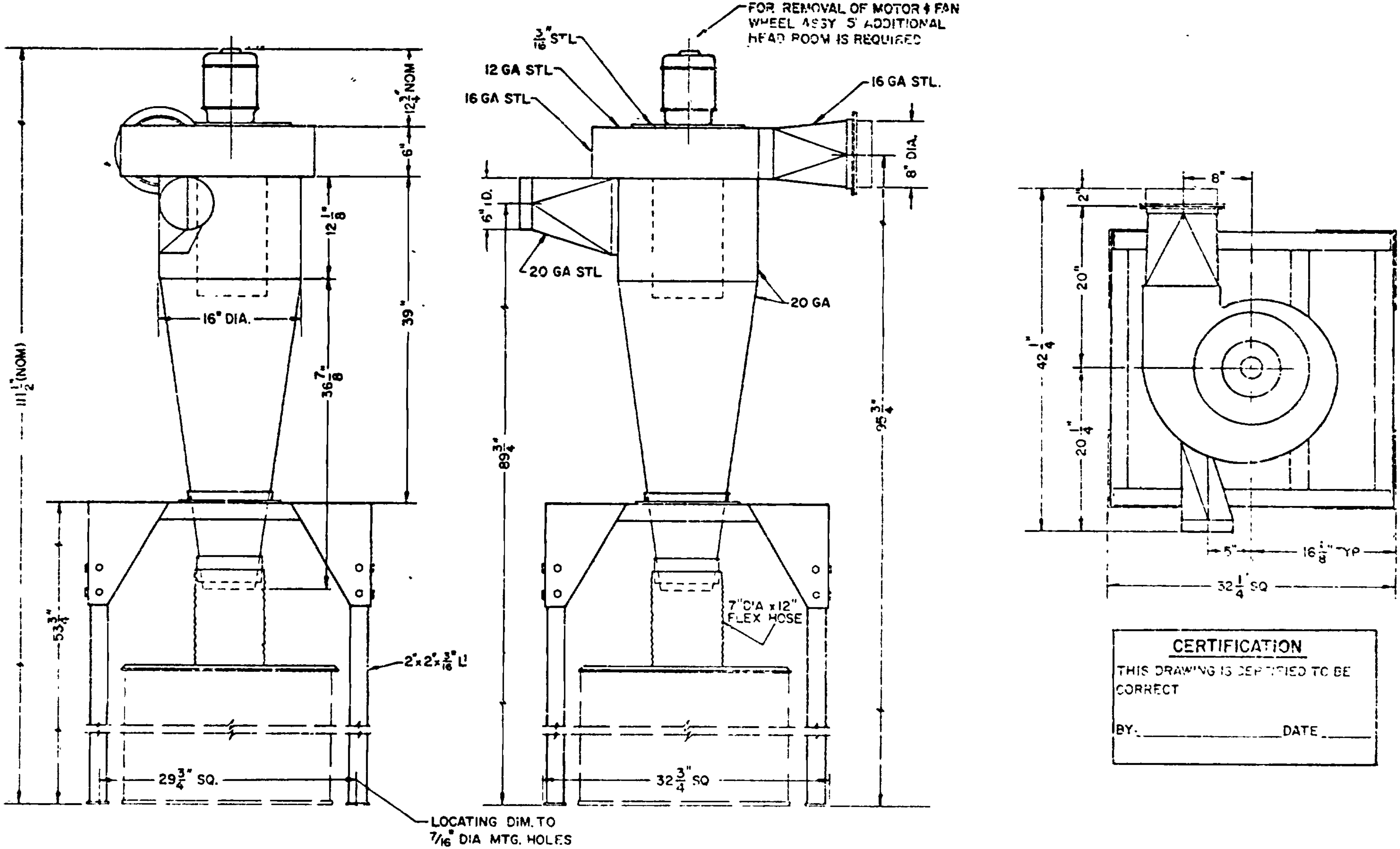
NOTES

1. INLET MAY BE ROTATED ... INCREMENTS IN FIELD
2. OUTLET MAY BE ROTATED ... INCREMENTS IN FIELD

TORIT

MODEL NO 19 FM CYCLONE

19-000



MULTIPLE RATING TABLES

C.F.M.	VELOCITY (FPM)	EXT. S.P.
2'0	6135	4.6"
[illegible]	[illegible]	5.4"
[illegible]	5565	6.6"
[illegible]	[illegible]	7.5
[illegible]	4706	7.9"

SPECIFICATIONS

1. MOTOR SHALL BE 2HP, 3600 RPM 230-460/60/3
2. DRUM CAPACITY SHALL BE 7.5 CU. FT
3. INLET: 6" I.D
4. OUTLET: 8"
5. NET WT. 355#, SHIPPING WT. 390#
6. FAN SIZE 13" x 3 1/2", MAT'L HANDLING DESIGN

NOTES

1. INLET MAY BE ROTATED AT 90° INCREMENTS IN FIELD
2. OUTLET MAY BE ROTATED AT 45° INCREMENTS IN FIELD
3. THIS DRAWING IS FOR [illegible] 19FM-55 CYCLONE [illegible]
4. [illegible]
5. [illegible]
6. [illegible] MOTOR SUPPLIED OR SPECIFIED MAY VARY FROM [illegible] SHOWN. TORIT WILL [illegible] WHERE REQD

TORIT

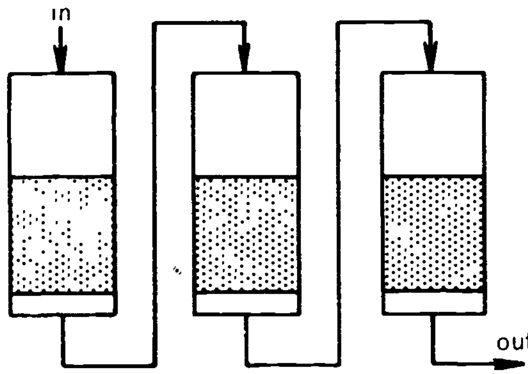
THE TORIT CORPORATION ST. PAUL, MINN. 55116
SPECIFICATION CONTROL DRAWING
MODEL NO 19FM-55 CYCLONE
DRAWN [illegible] DRWG NO 19-002
APPD [illegible]

ADSORPTION DESIGN GUIDELINES FOR GRANULAR ACTIVATED CARBON IN WASTE TREATMENT

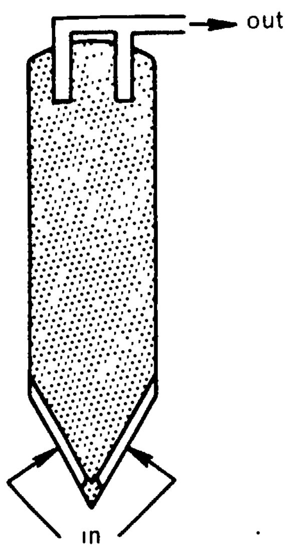
CALGON ACTIVATED CARBON APPLICATION BULLETIN

Adsorber configuration for granular carbon waste treatment and/or water reclamation systems normally can be classified into three basic designs as follows:

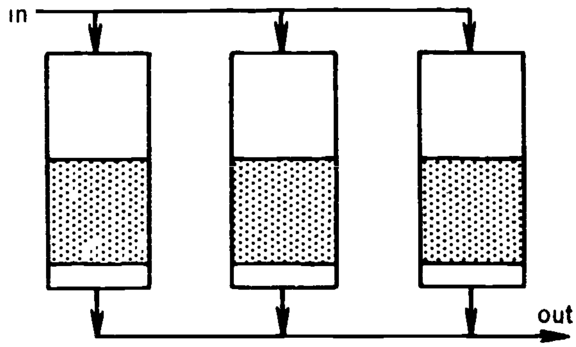
1. Fixed Beds in Series
   The units are operated downflow in series with each carbon bed being replaced as a complete batch. Replacement of carbon is made at the effluent end of the series with each carbon bed being utilized counter-current to the waste flow. This design is of value for larger volume plants with anticipated backwash requirements.



2. Moving Beds
   This technique is a refinement of the counter-current operating principle. Flow is upward through the bed with *portions* of the bed being periodically removed from the bottom of the vessel. Fresh carbon is added to the top of the column. This design is most useful for small volume systems.



3. Fixed Beds in Parallel
   Each unit is in parallel downflow operation with the carbon bed being replaced as a single batch upon depletion of adsorption effectiveness. The startup of the units is staggered so exhaustion of the beds will be in sequence. Blending of fresh carbon effluent with partially exhausted carbon effluent prolongs the useful life of each bed before replacement is necessary. This design also favors large volume plants with backwash requirements.



Dependent upon the suspended solid load in the carbon bed influent, prefiltration may be desirable. Whether or not prefiltration is provided it is helpful to backwash the carbon beds for the following reasons:

1. To remove carbon fines generated in shipment and bed placement.
2. To remove accumulated suspended matter.
3. To remove air pockets which can accumulate in certain water conditions.
4. To help control bacteria which may tend to grow in the adsorption vessels.

Mechanical features of the adsorbers associated with a backwash system include:

1. Adequate underdrain design to assure uniform water flow throughout the bed.
2. Freeboard between the top of the bed and the exit port to allow for bed expansion.
3. Surface wash nozzles to facilitate separation of suspended matter from granular carbon via scrubbing action.

Recovery of valuable products after their adsorption on granular carbon is feasible in some instances. Removal of the product from the carbon can sometimes be accomplished with chemicals, solvents, and/or steam. Complete recovery is not always effected for each cycle and the carbon may require reactivation or replacement after a given number of recovery cycles. The equipment for these systems is dependent upon the waste stream and the product to be recovered.

CALGON REACTIVATION OF GRANULAR CARBON

CALGON ACTIVATED CARBON APPLICATION BULLETIN

During the purification of water and waste, impurities removed from solution collect in the pores of the granular activated carbon particles, reducing their effectiveness. These impurities can be removed economically from the carbon by thermal reactivation.

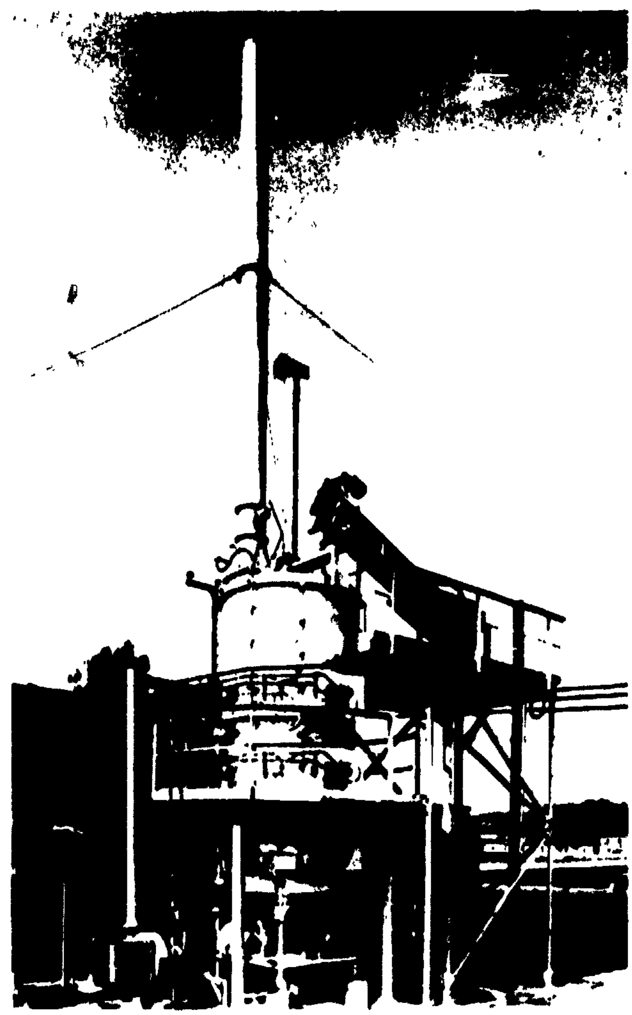
The basic sequence for reactivation is as follows: The granular carbon is pumped in a water slurry from the filtration/adsorption equipment to the reactivation area. The carbon is dewatered and fed to a multi-hearth furnace where it is heated to 1500-1700° F. in a controlled atmosphere which volatilizes and oxidizes the adsorbed impurities. The hot reactivated carbon is then quenched in water and pumped back to the filtration/adsorption equipment or to storage. An average loss of 5% occurs in the reactivation sequence so that an average life of 20 cycles can be estimated for the granular carbon beds. Make-up carbon is added following each reactivation cycle to maintain bed volume.

Selection of the particular grade of granular activated carbon to be used in water or waste treatment involves several key factors. The carbon should possess an adsorption capacity for the impurity or group of impurities to be removed. In addition, the particle size or mesh size range should be carefully selected to optimize the rate of adsorption and to be consistent with other design parameters such as suspended solids removal and backwashing requirements.

From the standpoint of physical properties, the granular activated carbon must possess sufficient hardness to allow hydraulic and mechanical handling associated with the reactivation process. Adequate density as well as hardness is also required to make backwashing (including surface wash techniques) easy and effective. The granular activated carbon used in most reactivation systems throughout the world is made from bituminous coal and is manufactured by Pittsburgh Activated Carbon Company, a wholly-owned subsidiary of Calgon Corporation. (Bulletin No. 20-1 describes the granular activated carbon recommended for water treatment, and Bulletin No. 20-2 for waste treatment.)

Investment and operating data

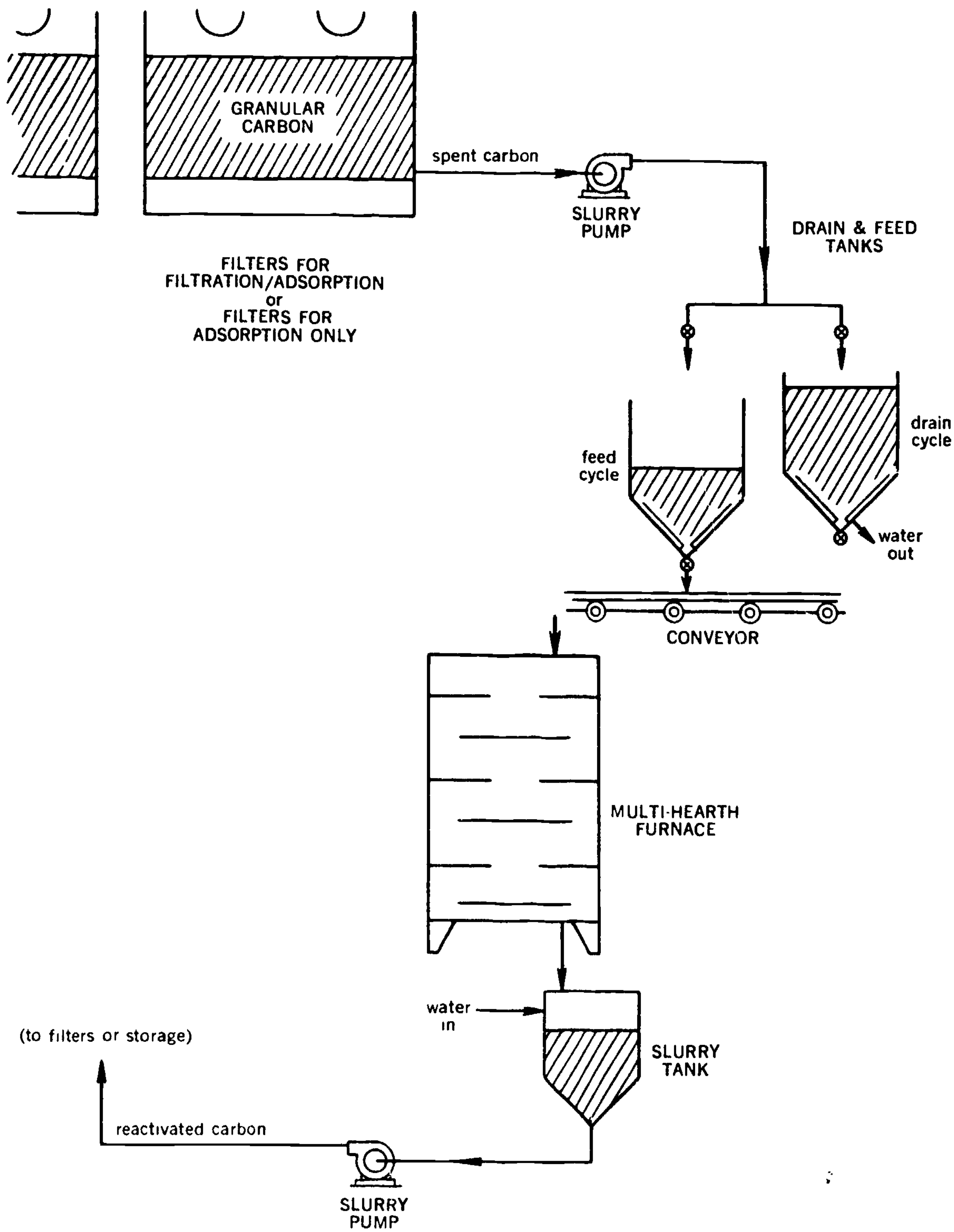
Investment costs vary with the size of the installation and more specifically with the amount of carbon reactivated on a daily basis. Direct operating costs for reactivation also vary with the size of the installation but generally fall into the 2¢ - 5¢ per pound range. This estimate would include fuel, power, labor and make-up carbon. Detailed estimates of investment and operating costs for specific installations can be provided upon request.



Eight-hearth gas-fired reactivation furnace has a nominal capacity of 500 pounds per hour. Furnace operates at 1600 to 1800°F to burn adsorbed organic contaminants from granular carbon.

equipment

The following diagram summarizes the basic components in a granular carbon reactivation installation:



For further information, write to Filtrasorb Department, Water Management Division, Calgon Corporation, P.O. Box 1346, Pittsburgh, Pa. 15230.

CALGON

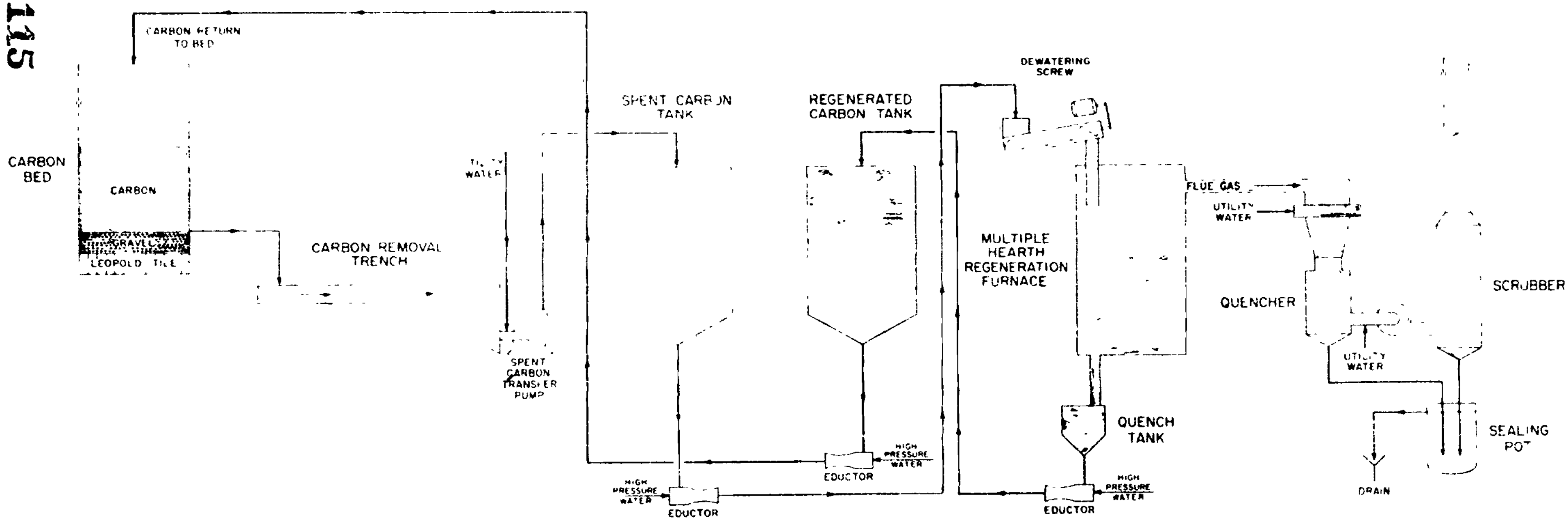
SUBSIDIARY OF MERCK & CO., INC

Printed in U S A

AtlanticRichfieldCompany
WATSON REFINERY

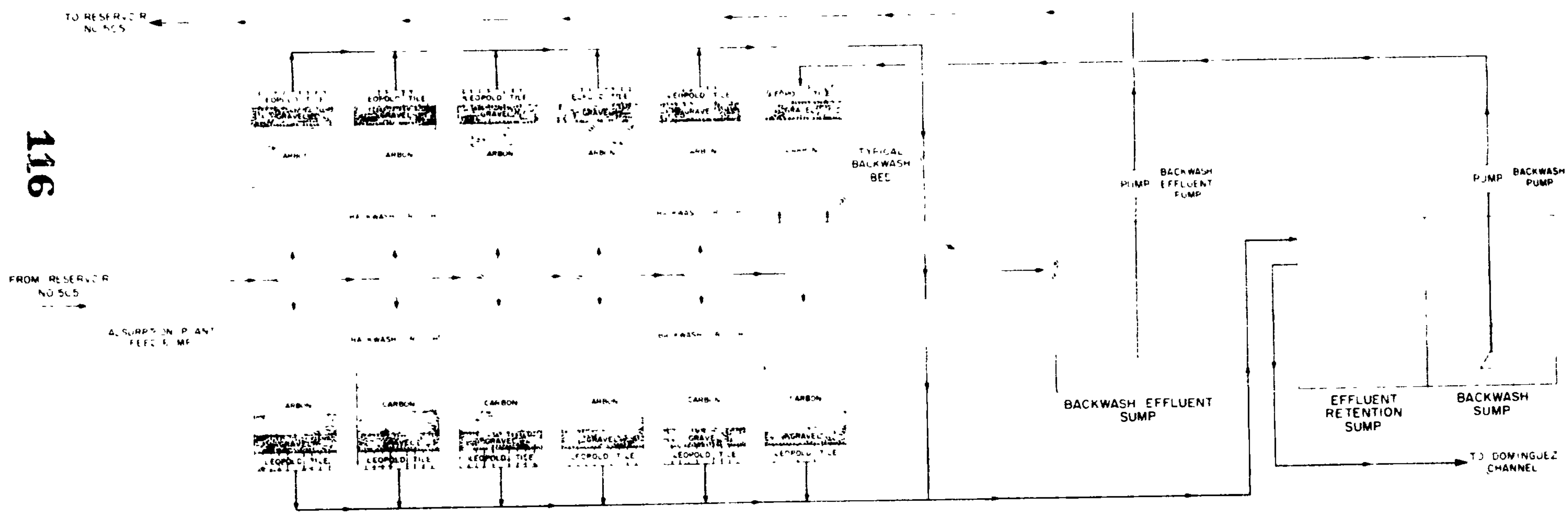
WASTE WATER ACTIVATED CARBON TREATMENT PLANT

CARBON TRANSFER AND REGENERATION SYSTEM



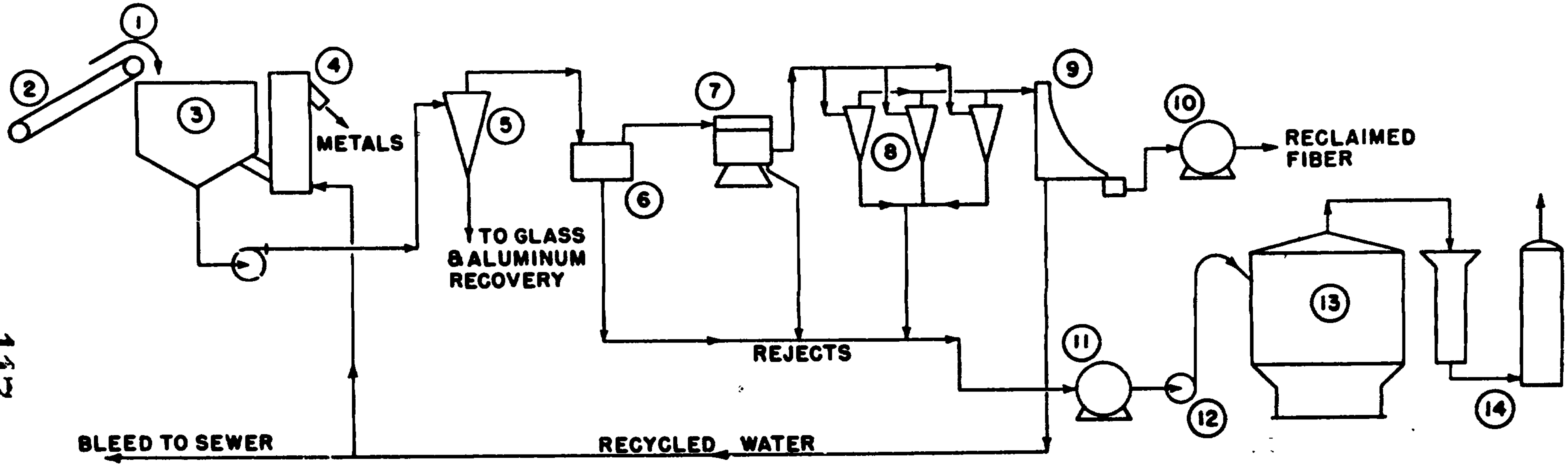
AtlanticRichfieldCompany
WATSON REFINERY

WASTE WATER ACTIVATED CARBON TREATMENT PLANT



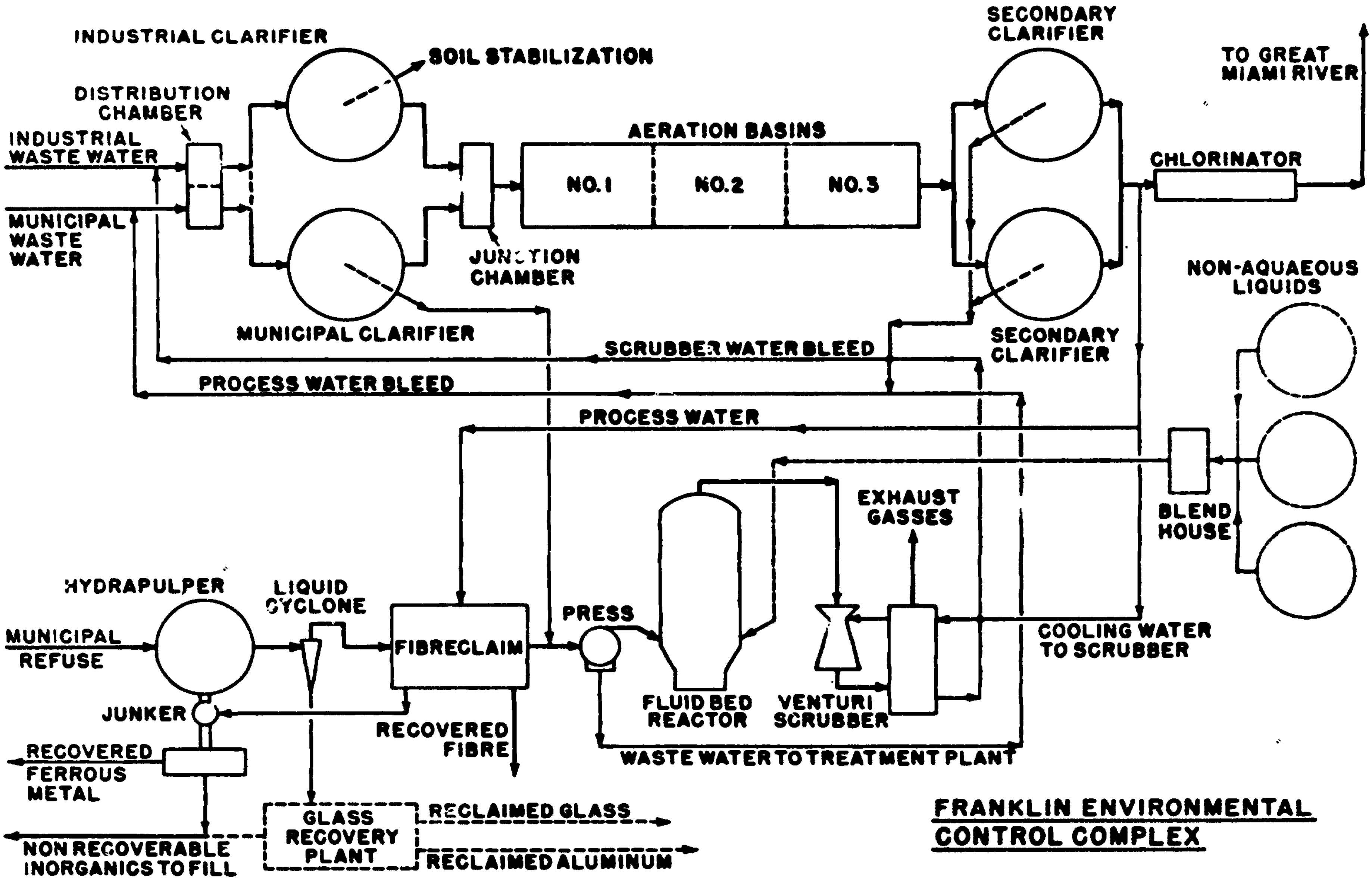
ACTIVATED CARBON ADSORPTION BEDS
SIZE OF EACH PIT 12-0" X 12-0" X 26'-0" DEEP
CARBON DEPTH EACH BED 13-0'
48,500 POUNDS CARBON EACH BED
TOTAL CARBON IN 12 BEDS 583,500 POUNDS

The Black Clawson Company



1 SOLID WASTE
2 FEED CONVEYOR
3 HYDRAPULPER
4 JUNK REMOVER
5 LIQUID CYCLONE
6 CLASSIFINER
7 SCREEN
8 CENTRIFUGAL CLEANERS
9 FINES SCREEN
10 CONE PRESS
11 CONE PRESS
12 PNEUMATIC FEED
13 FLUID BED REACTOR
14 VENTURI SCRUBBER

FLOW SHEET - SOLID WASTE PLANT - FRANKLIN, OHIO



FRANKLIN ENVIRONMENTAL
CONTROL COMPLEX

The Black Clawson Company

DEPARTMENT OF THE NAVY, Study of Equipment and Methods for Removing and Dispersing Oil from Open Waters, August 1970.

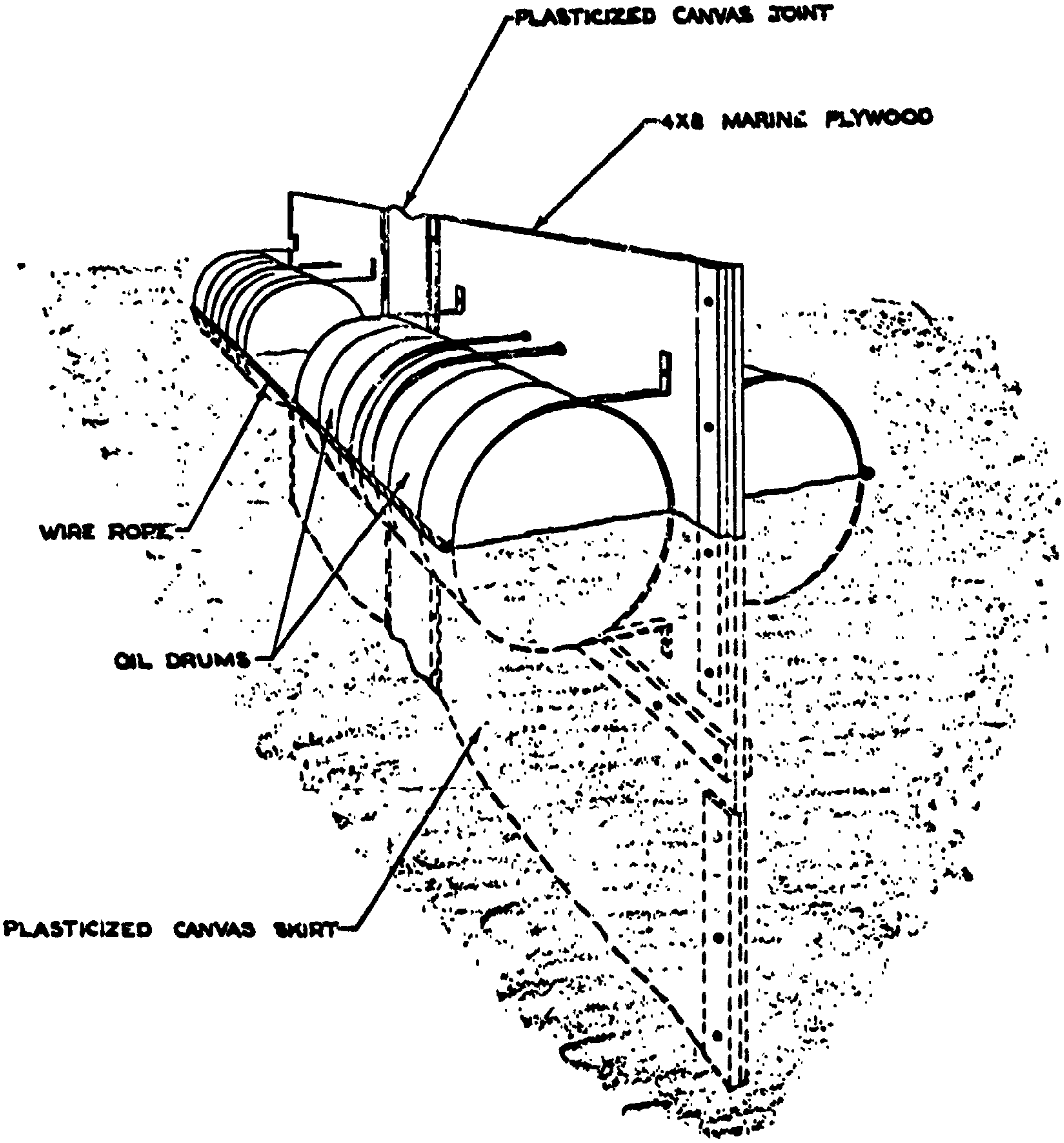
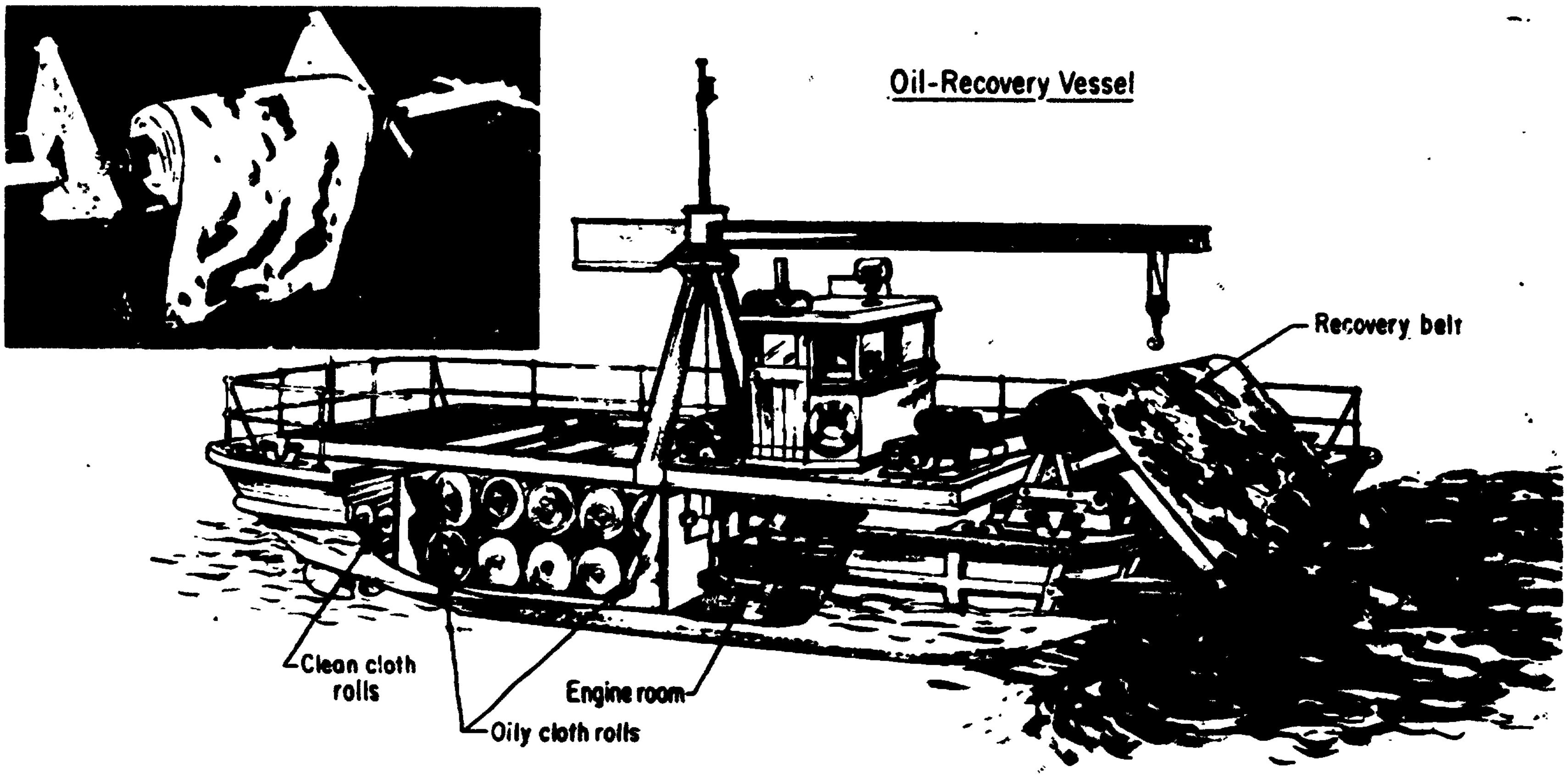


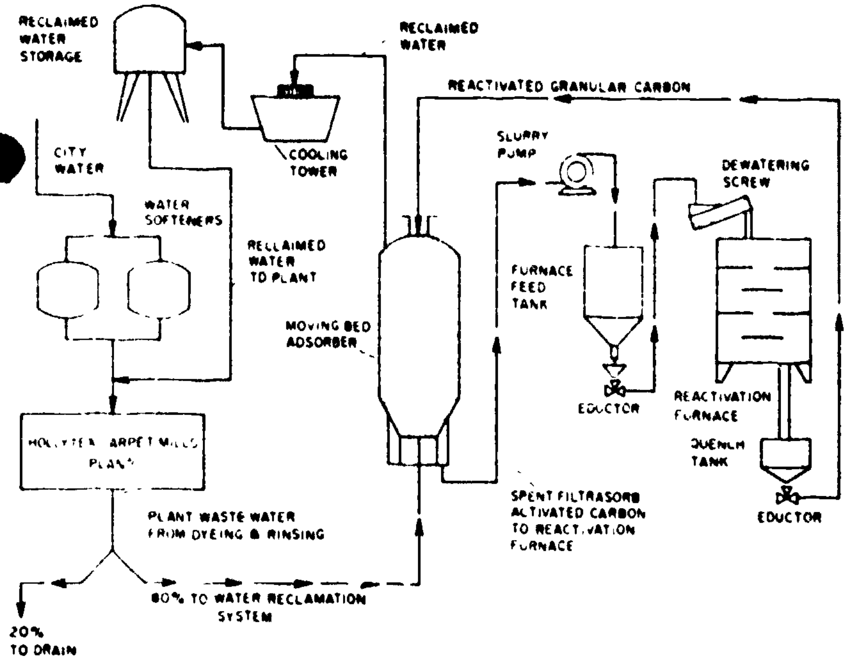
Figure D-12 Navy heavy duty oil pollution containment boom produced by Murphy Pacific Marine Salvage Company



Proposed British vessel would pick up oil film on large cloth rollers (inset).

Figure D-30 Mutton cloth roll skimmer developed by
Oswald Hardie, chief engineer, Port of Manchester, England

DEPARTMENT OF THE NAVY, Study of Equipment and Methods for Removing and Dispersing Oil from Open Waters, August 1970.



WASTE WATER FROM DYE VATS *is economically reclaimed for reuse in activated-carbon system at $4 million plant of Hollytex Carpet Mills in Southampton, Pennsylvania*

pollution control

RECLAMATION OF 500,000 GAL/DAY *of waste water, from plant carpet dyeing operations, saves on water cost and prevents any possibility of causing a problem for community's sewer facilities*

Water reclamation promises savings of $80,000 per year

Activated-carbon system avoids trouble for municipal sewer

NEW SOLUTIONS OF PLANT PROBLEMS

At Hollytex Carpet Mills plant, Southampton, Pennsylvania, an activated-carbon, water-reclamation plant will provide potential savings in water cost of over $80,000 yr. System will reclaim 80% of water, used in plant's carpet-dyeing operations, for reuse. Capacity of system is 500,000 gal/day, with provision for ready expansion to one million gal/day as needs increase.

Cost to purchase this quantity of water, and to pay charges for disposal to municipal sewers, would run $0.50 - 1000 gal. Reclamation reduces the cost to about $0.15-0.20 - 1000 gal. When plant requirements reach the expected one million gal/day, yearly savings will be over $80,000. In addition, reclamation prevents any problems for community's water and sewer facilities.

Production capacity of carpet mill is 10-million yards annually. Dye house is equipped with 15, gas-fired dye becks, which can dye 1700 lb of carpet with up to 4 tones. Water is extracted from dyed carpeting by vacuum and carpet dried in gas-fired dryers.

Approximately 80% of water from dyeing operations passes to reclamation system. Remaining 20% is discharged to a holding sump and is intermittently bled to municipal sewers on a regulated basis. If this portion of waste exceeds agreed on amount, additional quantities are reclaimed. Reclamation system can handle entire plant waste load should such be required.

Waste water flows upward through a moving-bed adsorber and is passed through a cooling tower. Cooled water is then pumped to an adjacent storage tower from where it is fed back to plant for making up new dye solutions and for rinsing of dyed carpeting.

In moving-bed adsorber, spent cotton is removed in slugs from bottom of tower, with reactivated and fresh makeup carbon added at the top. Spent carbon is conveyed in a water slurry to a holding tank. Slurry from tank is educted to a dewatering furnace-feed screw.

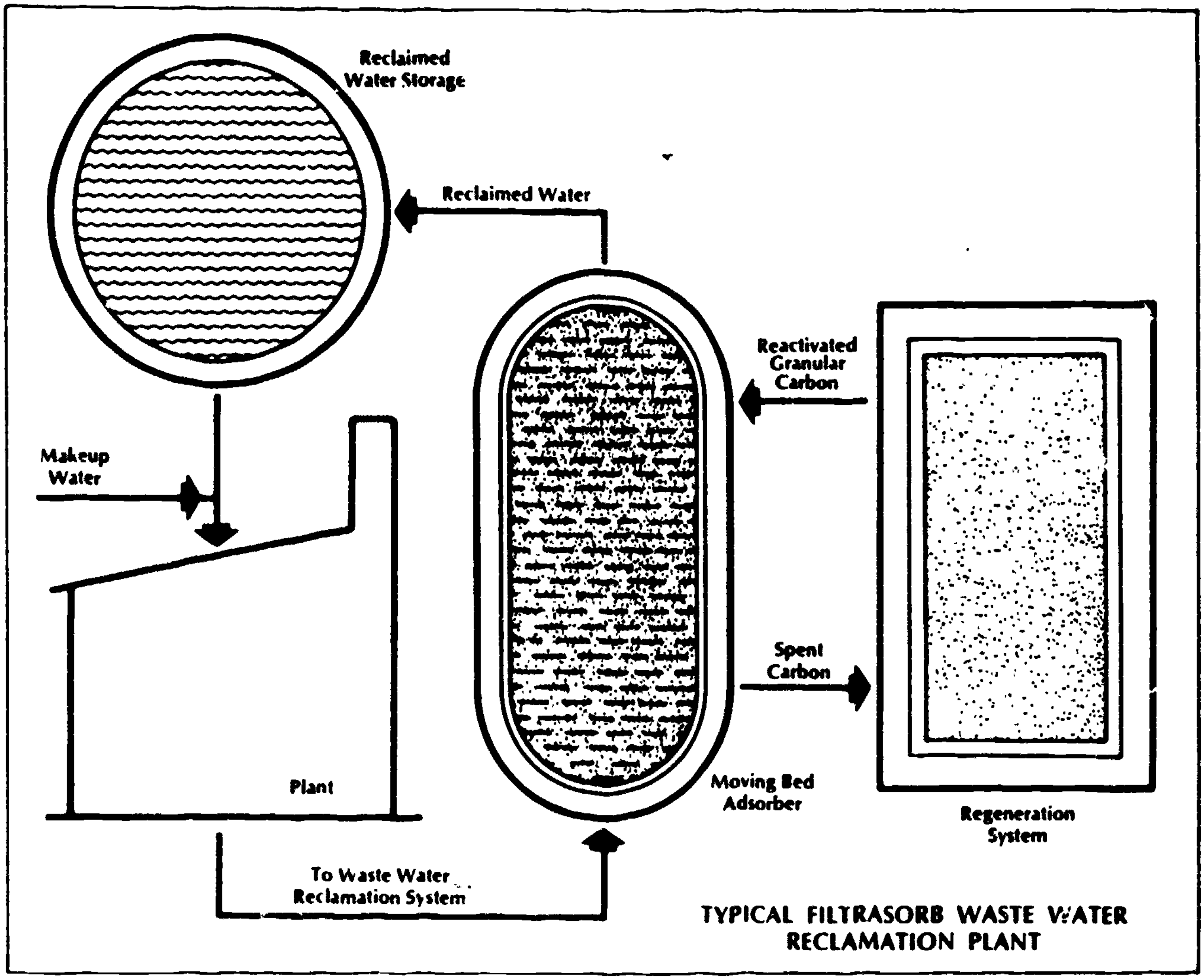
Carbon is [illegible] fed to a multiple-hearth [illegible] fired furnace equipped with a wet scrubber for removal of particulates from exhaust gases. Reactivated carbon is discharged from furnace to a quench tank. Resulting slurry is fed by air pressure to feed tank on top of adsorber.

Success of economically feasible waste-water reclamation system can be attributed to 2 developments in adsorption technology. Very hard, high-density, abrasion-resistant, granular carbon can be reactivated repeatedly for reuse. Coal-based material has high porosity. This product, plus improved carbon handling and reactivation techniques, hold carbon losses near 5%.

Adsorber is a plastic-coated, mild steel vessel with straight sides and cone bottom, 9'9" in diameter and 22" high, having a capacity of 2000 cu ft. It is filled with 50,000 lb of activated carbon, 12 x 40 U.S. Std. mesh size. Reclamation-plant cost was approximately $300,000, total mill cost $4-million. Although aerated lagoons probably could not treat dye waste-water to meet effluent stream standards, land area needed for lagoons to treat one million gal/day would have been 8 times that required for activated-carbon system. Entire plant is housed in a 50'-high, 50 x 100' building, including provision for doubling capacity. ∎

Supplier of Filtrasorb 400 granular activated carbon and turnkey contractor for reclamation plant was Water Management Div., Calgon Corp., Calgon Center, Pittsburgh, Pa. 15230

Reprinted from CHEMICAL PROCESSING — January, 1970



TYPICAL FILTRASORB WASTE WATER RECLAMATION PLANT

phenol...dye...insecticide wastes... Filtrasorb® solves tough waste problems

Problem: Waste from a chemical manufacturing plant containing up to 2,500 ppm phenol and other pollutants was being pumped into lagoons. Capacity was about to be exceeded. Overflow would have been disastrous.

Solution: A simple filter bed of Filtrasorb granular activated carbon, supplied by Calgon Corporation, averted an expensive problem. Lagoon wastes are filtered through the Filtrasorb which adsorbs (removes) phenol and other organic wastes including a deep red color. Chemical regeneration is being used to restore the adsorptive capacity of Filtrasorb for re-use, and at the same time it provides a bonus in recovered phenol.

Problem: An insecticide plant was ordered to shut down on a specified date by regulatory agencies because of heavy organic wastes in plant effluent.

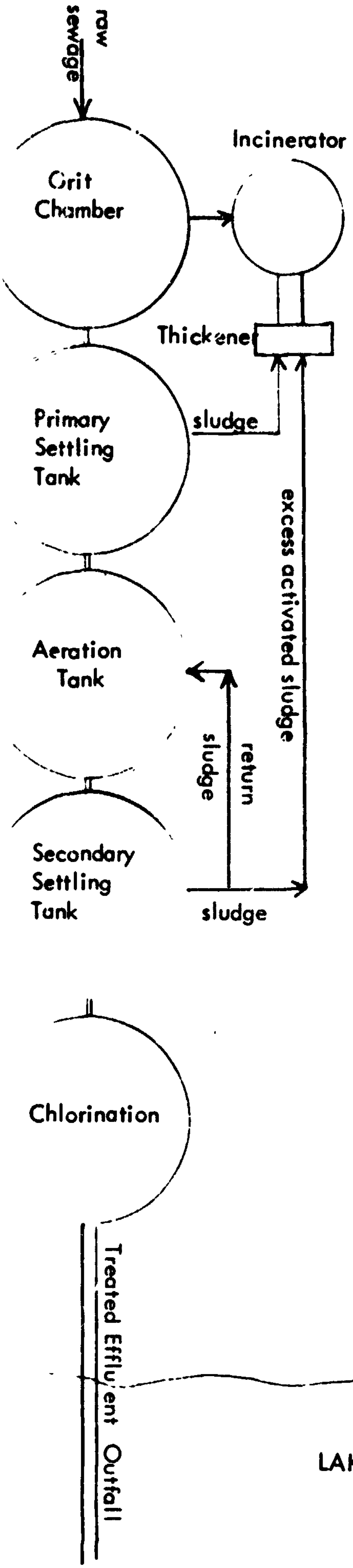
Solution: Adsorption with Filtrasorb proved to be the best answer. Filtrasorb engineers designed a plant that could be constructed quickly to prevent shutdown. The plant will treat an effluent containing mixtures of organic acids, phenol, mixed alcohols and many other chemicals. Filtrasorb will handle this complex job economically because it will be regenerated thermally for repeated re-use.

Problem: A new carpet mill expects to use 1,000,000 gallons of water a day eventually in its dyeing and rinsing operations. Projected costs for using municipal sources for this amount of water were well over $100,000 a year.

Solution: Calgon Corporation water specialists showed how Filtrasorb granular activated carbon could reclaim waste water economically. As a result, Calgon was awarded a contract for the design and construction of a complete Filtrasorb water reclamation plant which will provide a very substantial overall reduction in costs for the carpet manufacturer.

For the *tough* waste water treatment problems, call on the total capabilities of Calgon Corporation. Calgon can supply all, or any part of, the products and design technology for any Filtrasorb waste water treatment facility. For details, write or phone Filtrasorb Department, Calgon Corporation, Calgon Center, Pittsburgh, Pa. 15230 Phone (412) 261-5100.

EAST SIDE SEWAGE TREATMENT PLANT



The grit chamber screens out floating objects and allows most of the grit and sand to settle out; it is then conveyed to the incinerator for burning.

The primary settling tank allows the suspended wastes to settle out; they are then removed for burning.

The liquid left over from primary settling contains countless bacteria, which require plenty of oxygen to destroy the wastes. Air is pumped into the liquid to speed up the destruction of wastes by the bacteria.

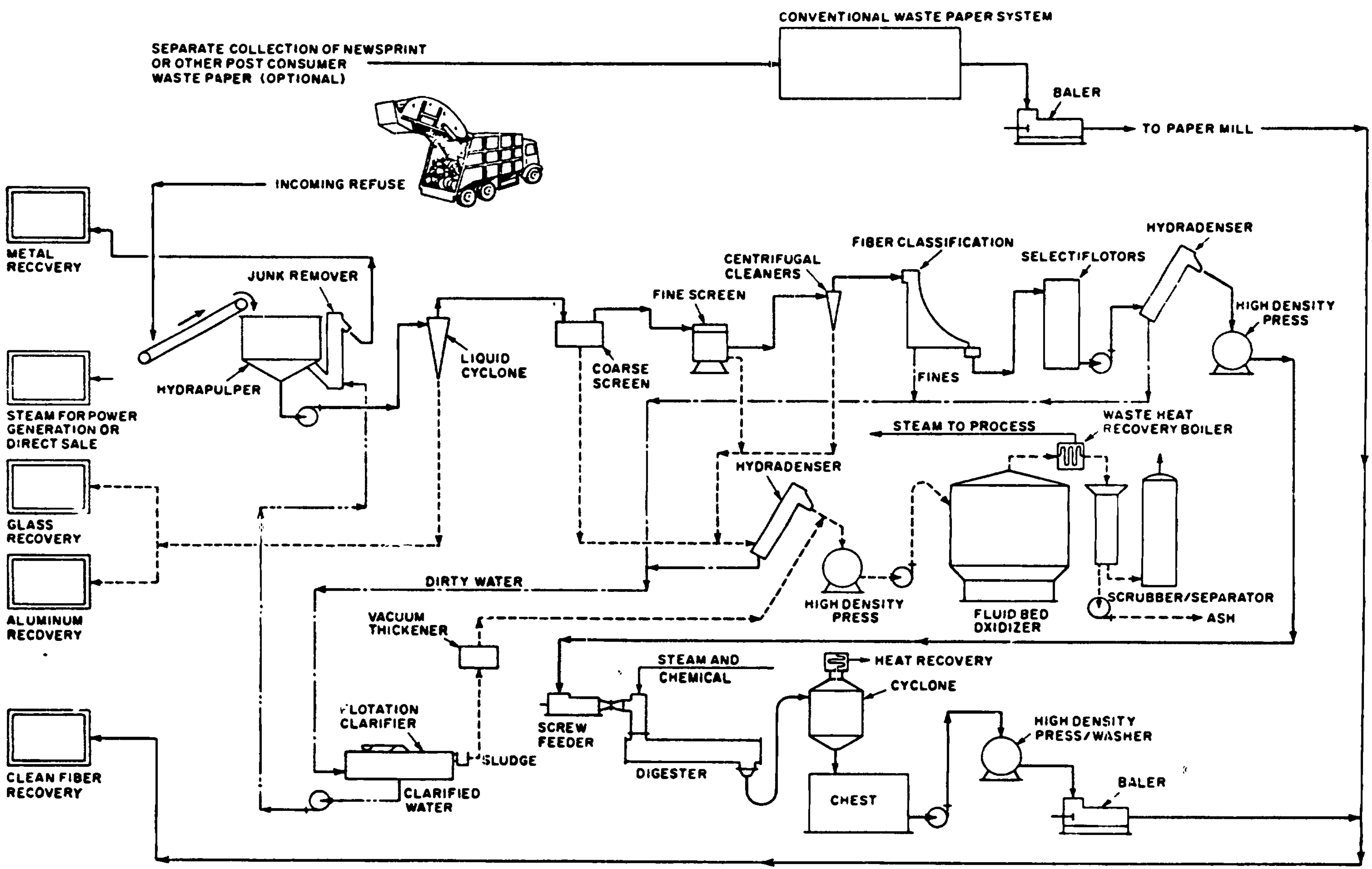
The sludge created in the aeration process is called activated sludge. Some is sent back to the aeration tank to provide more bacteria; the rest is sent to the incinerator for burning.

Finally, the liquid part, with nearly all the organic and inorganic wastes removed, is chlorinated to kill disease germs.

Then it is allowed to enter the lake, 1100 feet from the shore through a pipe which is underwater.

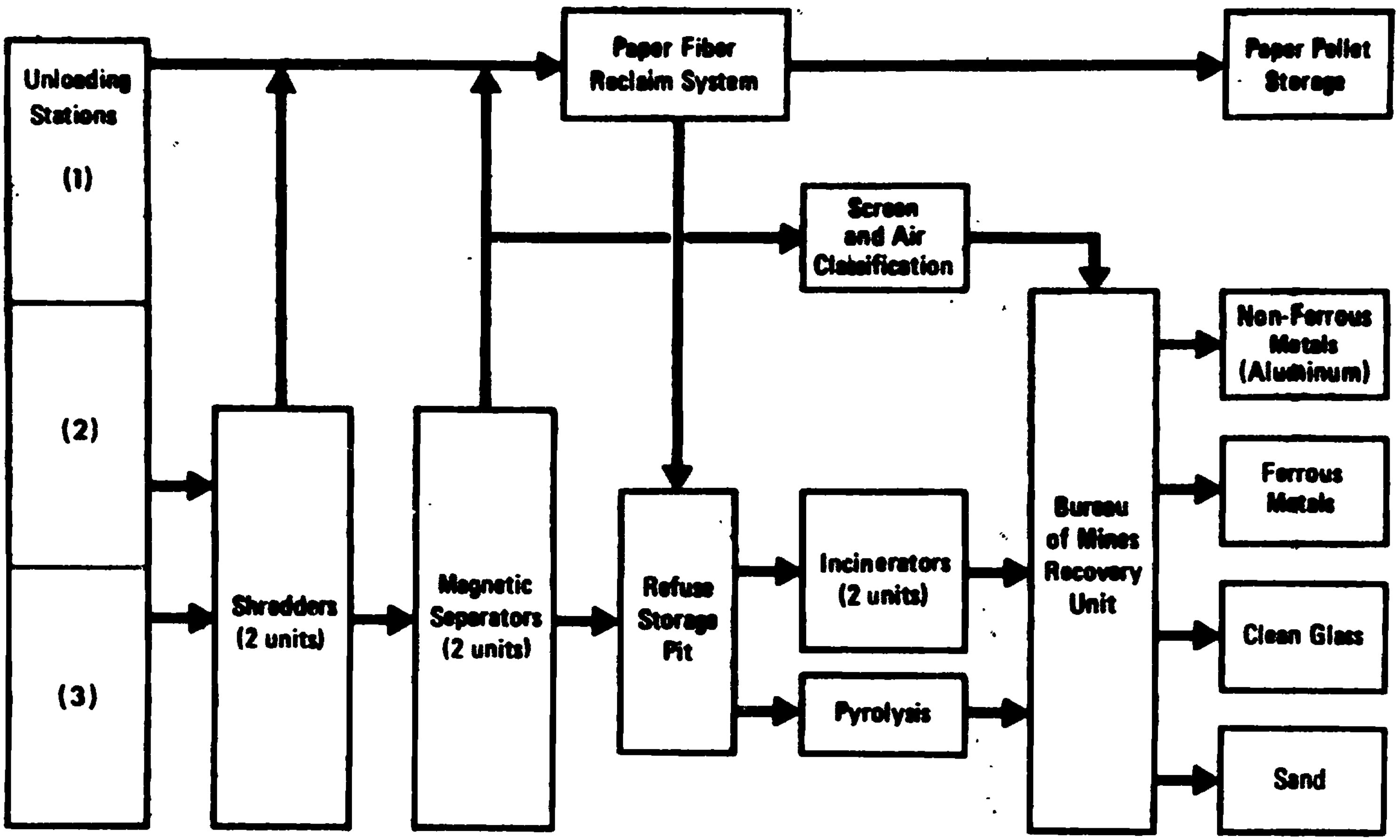
Prepared by Mr. Mario Scarsellietta, Chief Operator,
Water Pollution Control Facility, East Division
Oswego, New York

BLACK CLAWSON FIBRECLAIM, INC.
HYDRASPOSAL / FIBRECLAIM SYSTEM



4-40

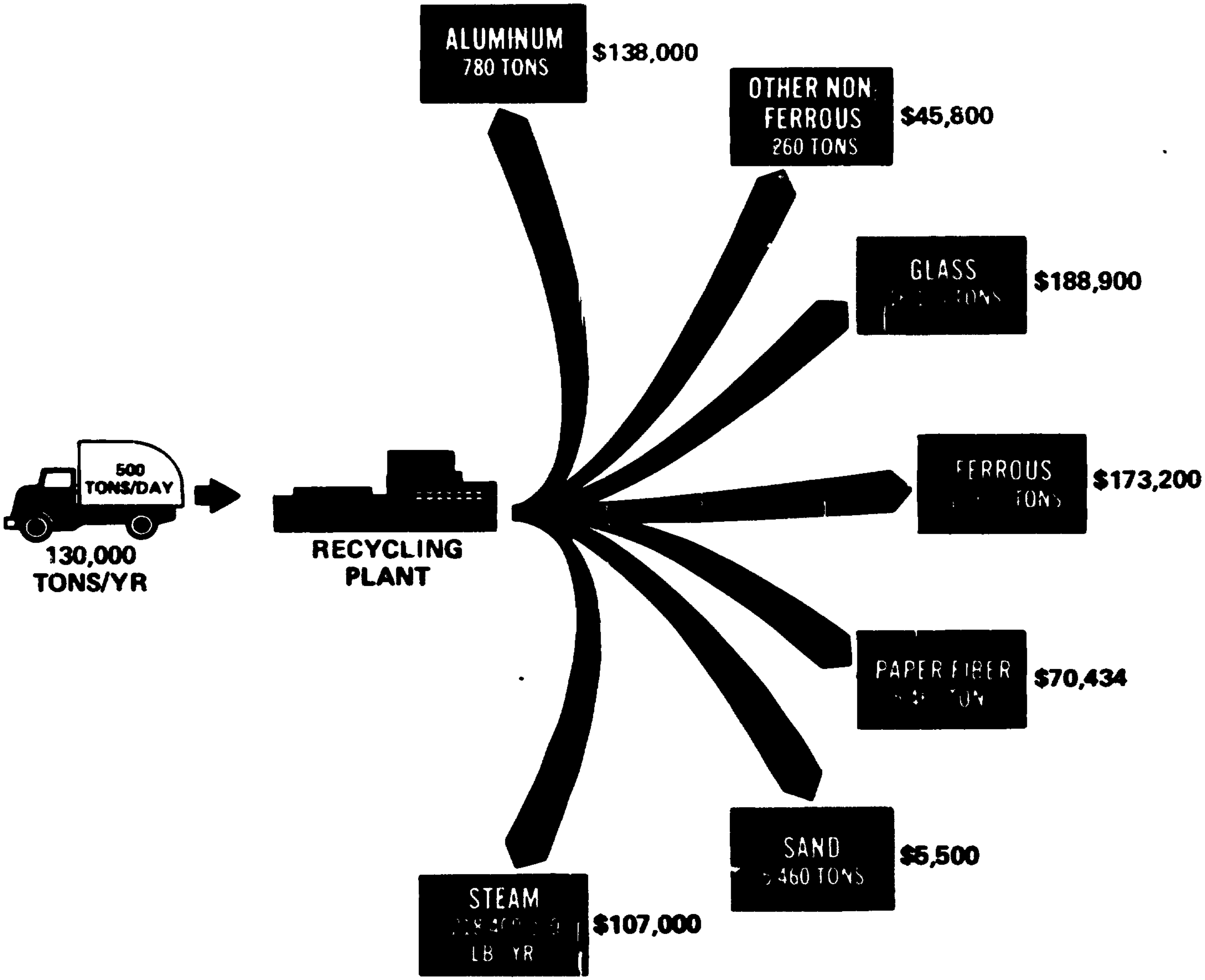
720127



RECYCLING PLANT FLOWCHART

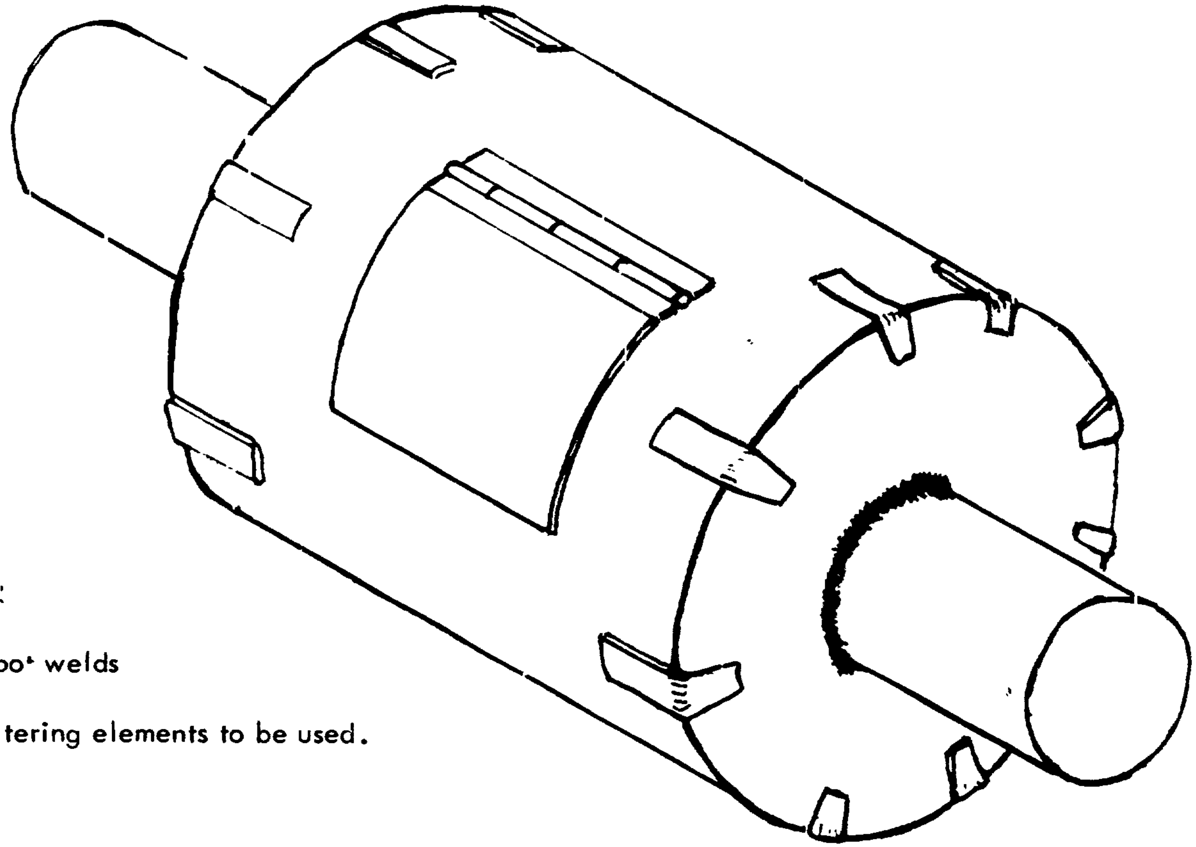
news

FROM THE ALUMINUM ASSOCIATION
750 Third Avenue
New York, NY 10017
(212) 972-1800



ANNUAL INCOME

news
FROM THE ALUMINUM ASSOCIATION
750 Third Avenue
New York, NY 10017
(212) 972-1800



EXPERIMENTAL AUTOMOBILE MUFFLER

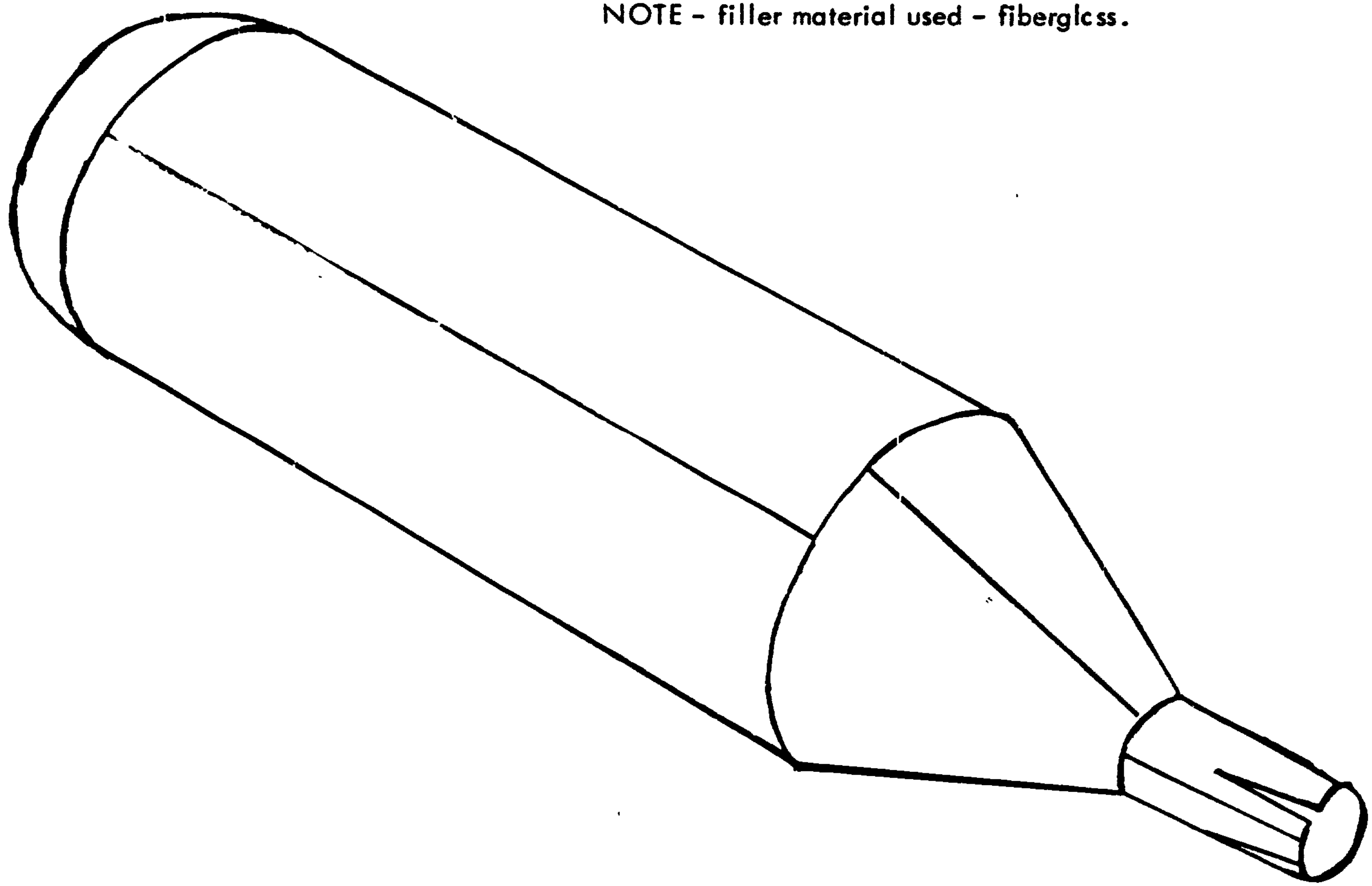
MATERIALS - sheet metal, fastened by spot welds

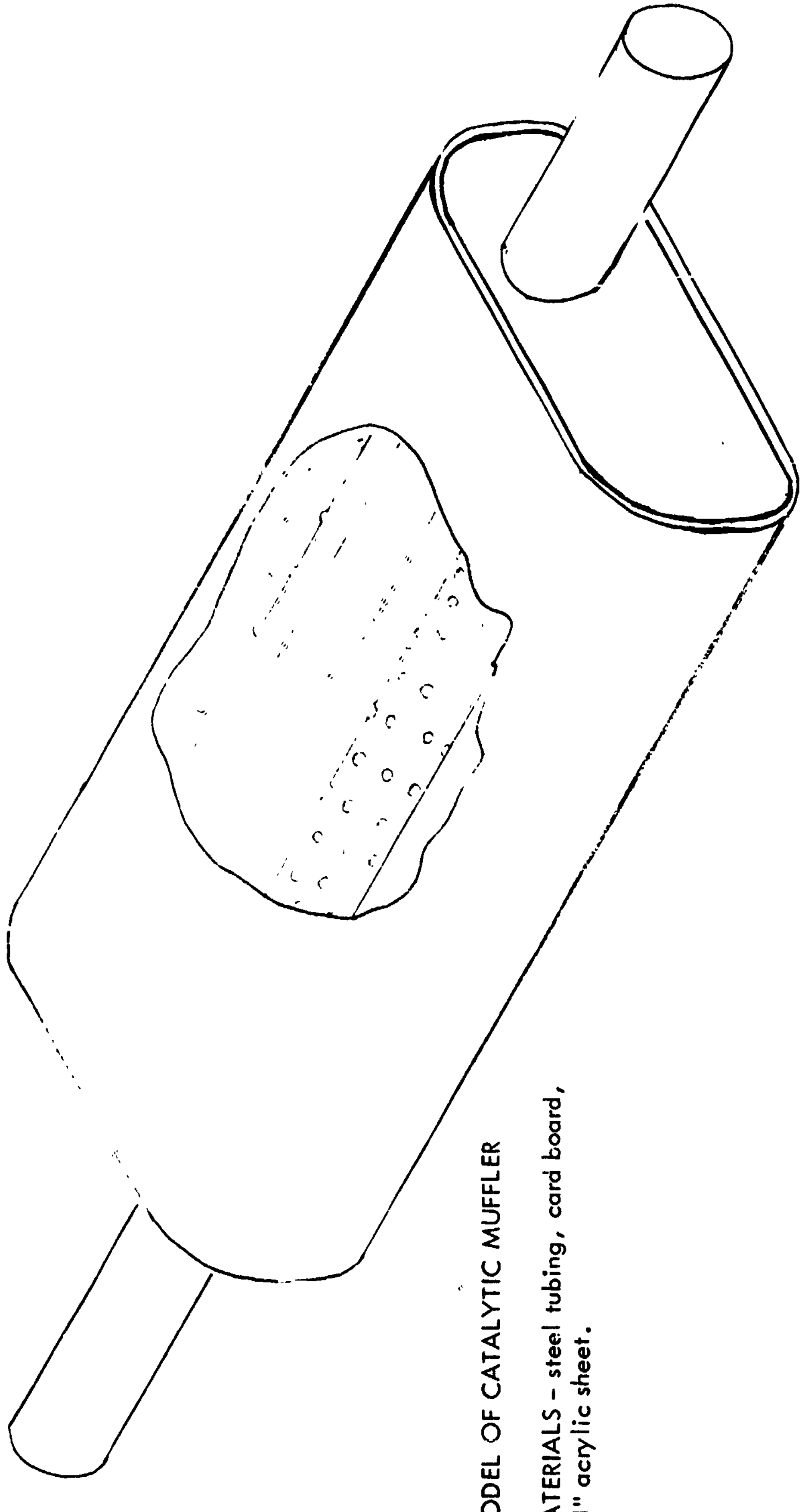
NOTE: door provided to allow various filtering elements to be used.

MINI - BIKE MUFFLER

MATERIALS - tin - plate, fastened by spot welds.

NOTE - filler material used - fiberglcss.



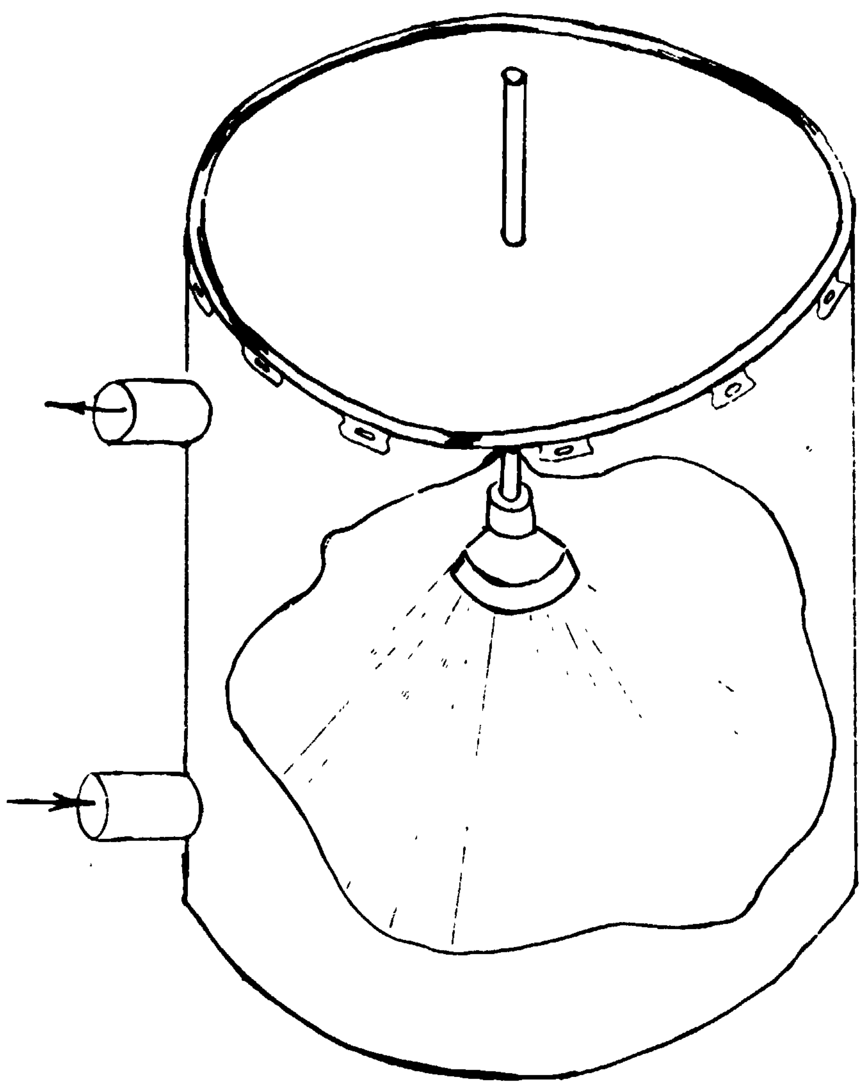


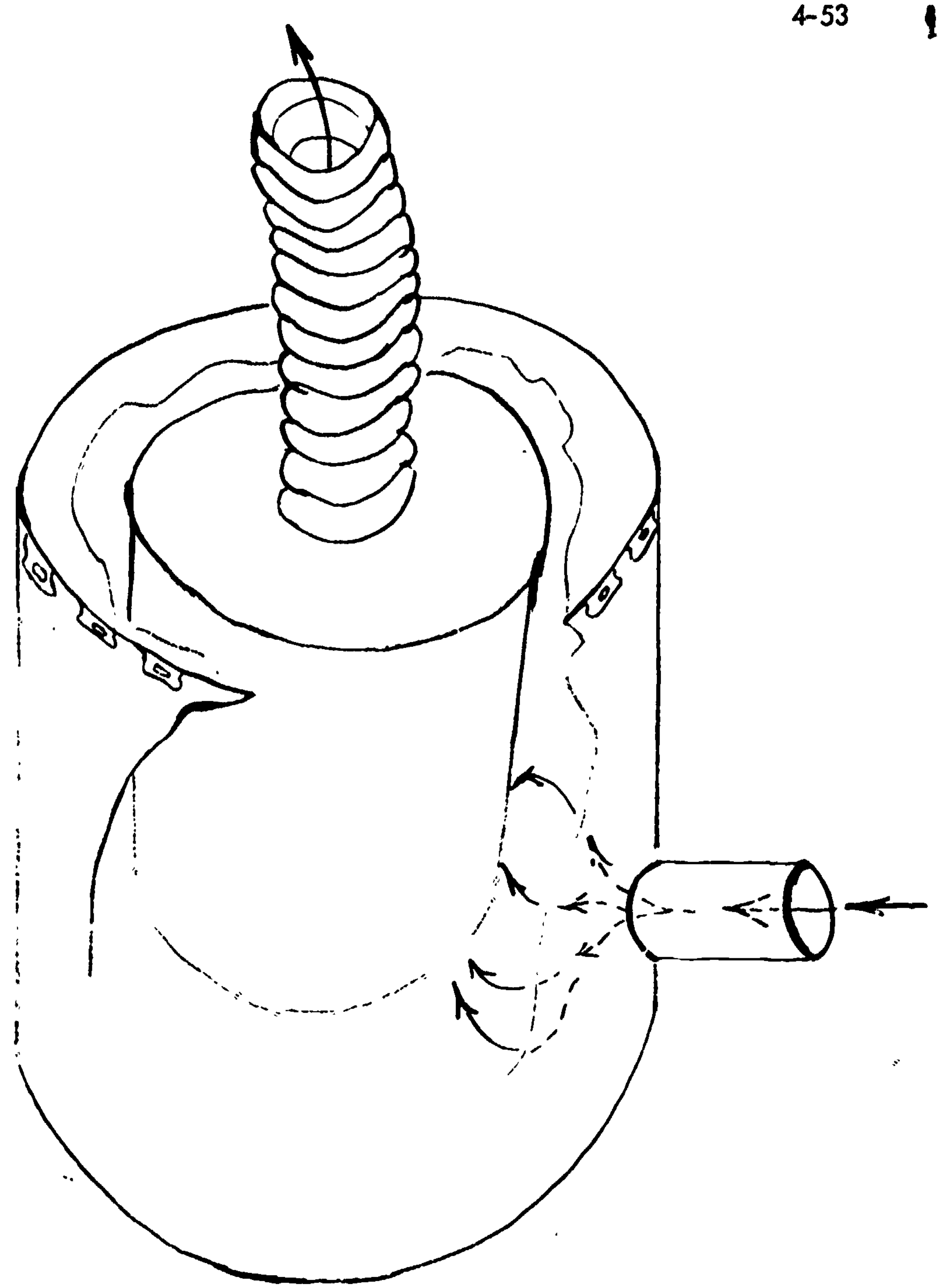
MODEL OF CATALYTIC MUFFLER

MATERIALS – steel tubing, card board, 1/8" acrylic sheet.

WET SCRUBBER

MATERIALS - five gallon pail, shower head.





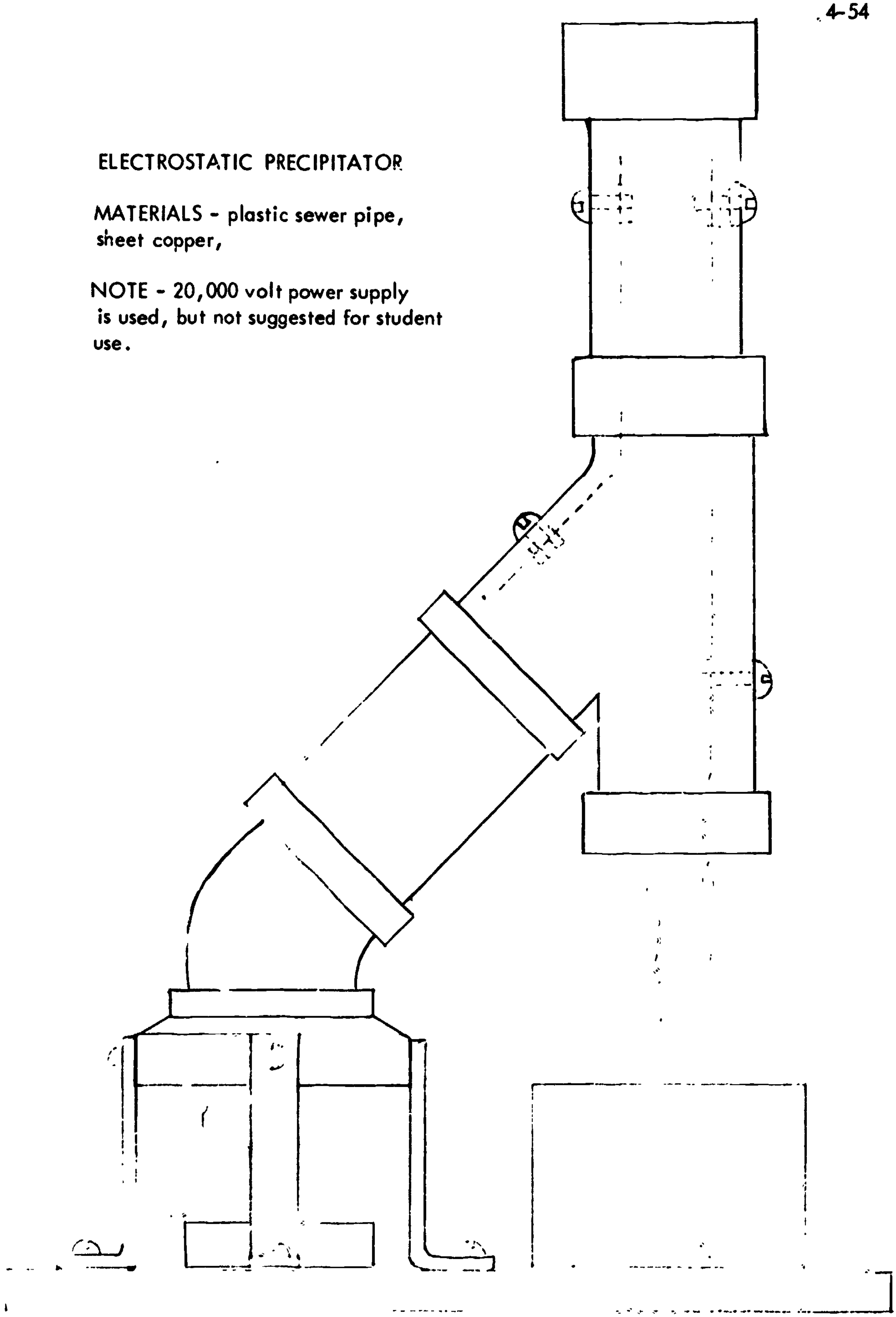
BAG FILTER UNIT

MATERIALS - five gallonpail, flexible hose, cloth filter.

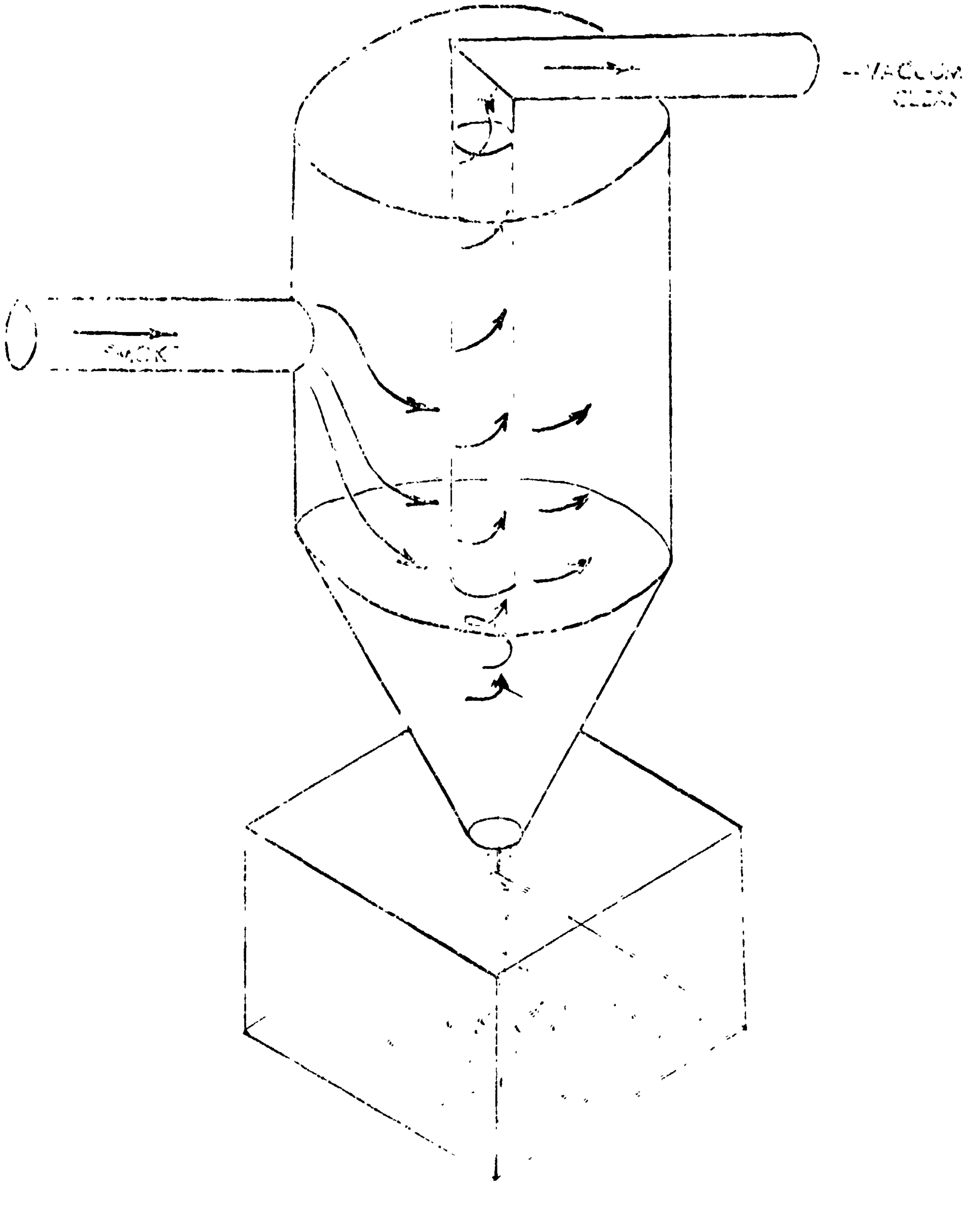
ELECTROSTATIC PRECIPITATOR

MATERIALS - plastic sewer pipe, sheet copper,

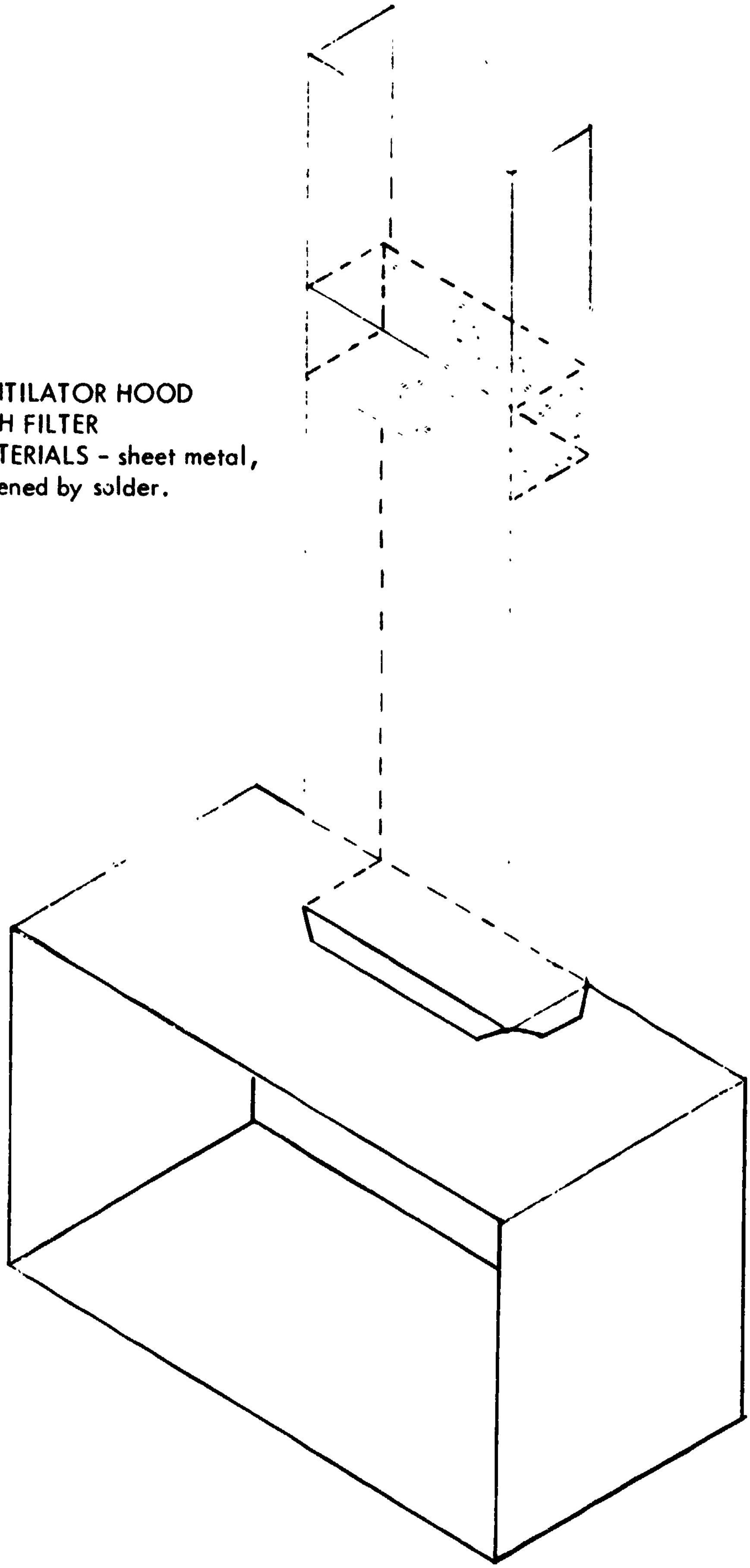
NOTE - 20,000 volt power supply is used, but not suggested for student use.

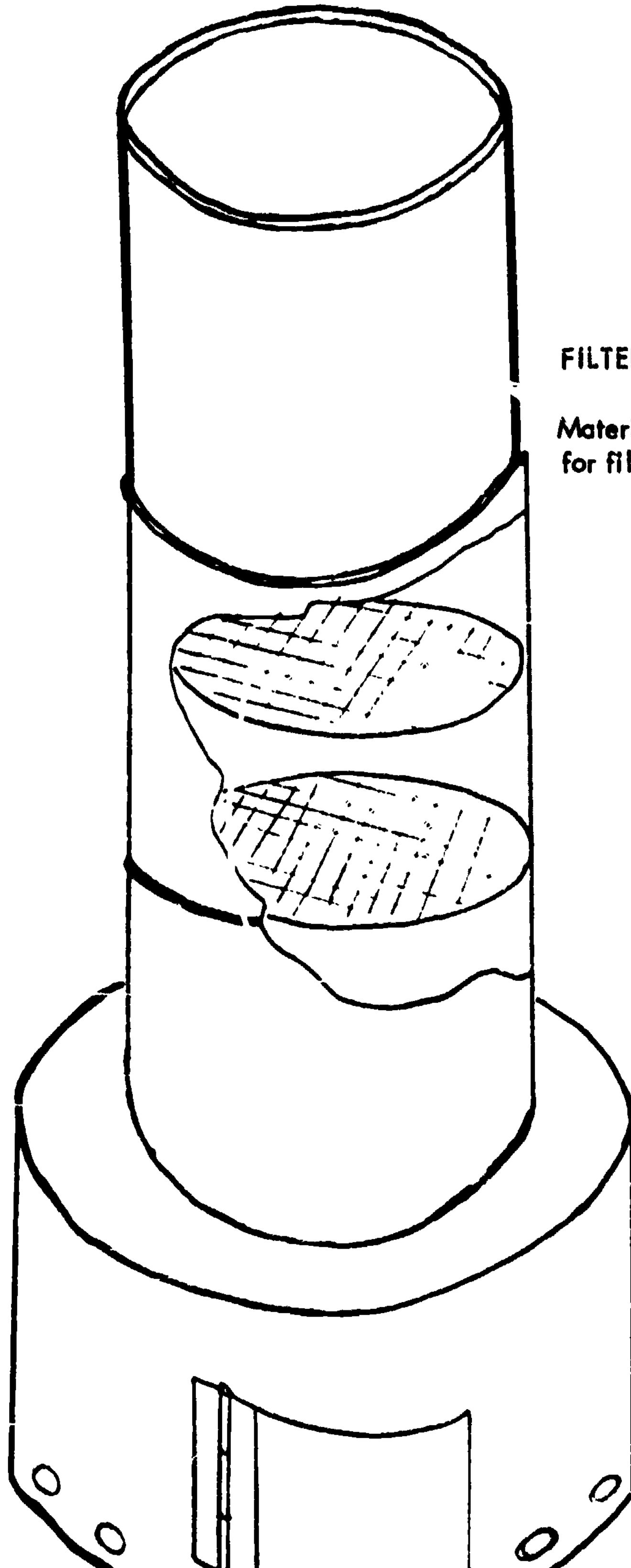


CYCLONE DUST COLLECTOR
Materials – Tin plate 3/4" tubing



VENTILATOR HOOD
WITH FILTER
MATERIALS - sheet metal,
fastened by solder.



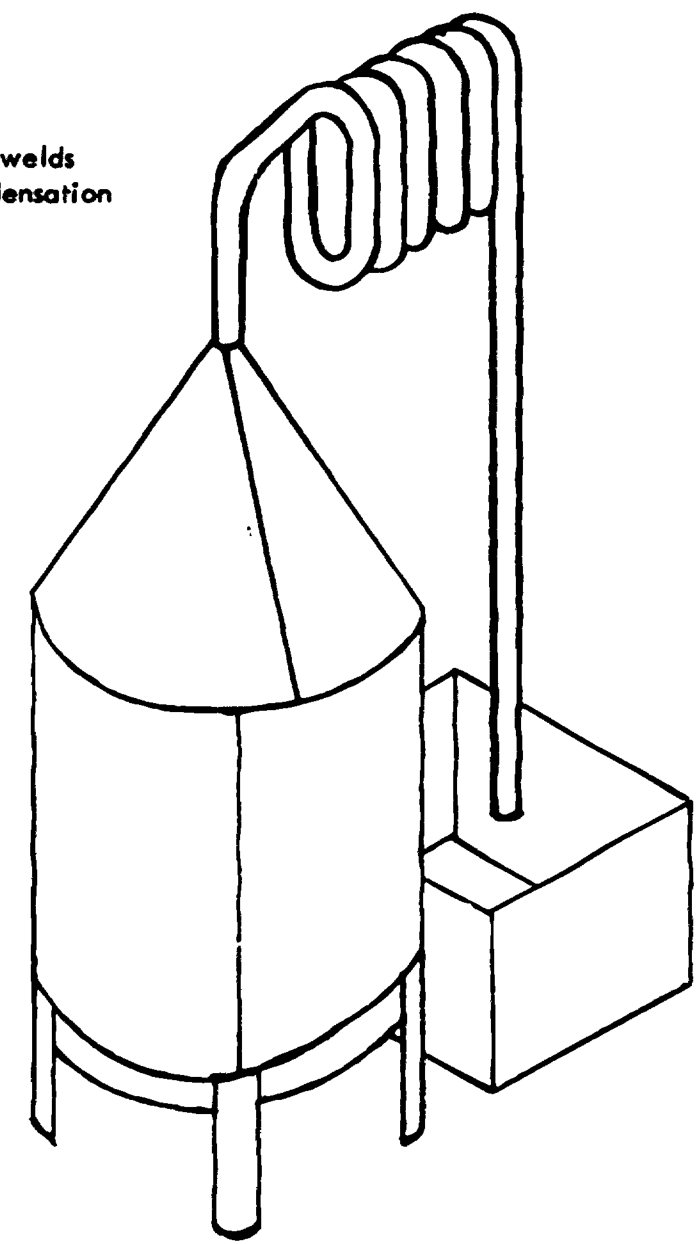


FILTERED SMOKE STACK

Materials - tin cans, fiberglass for filter, fastened by solder.

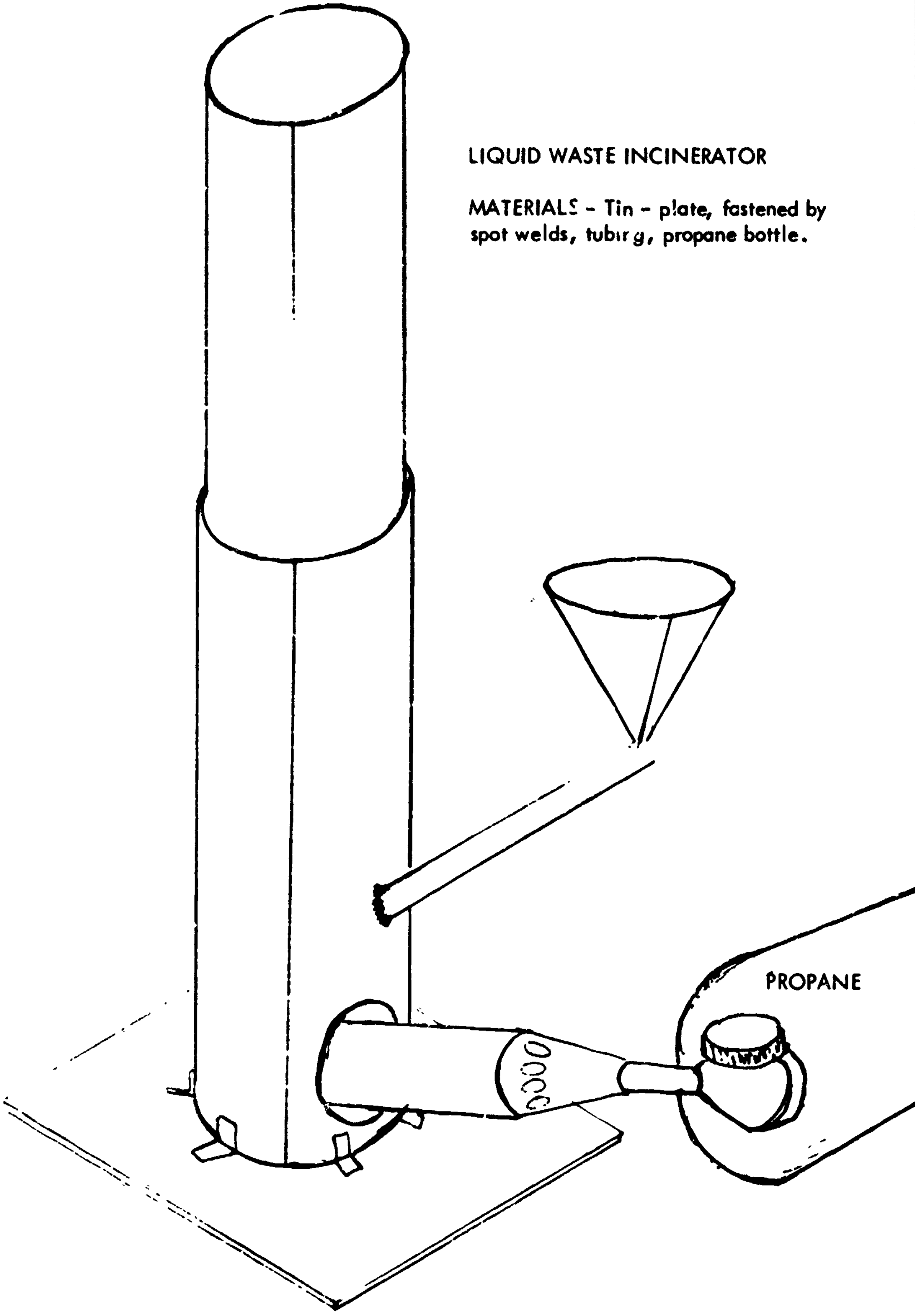
WATER DESALINAZATION UNIT

MATERIALS - sheet steel, fastened by spot welds
1/4" copper tubing, for condensation unit.



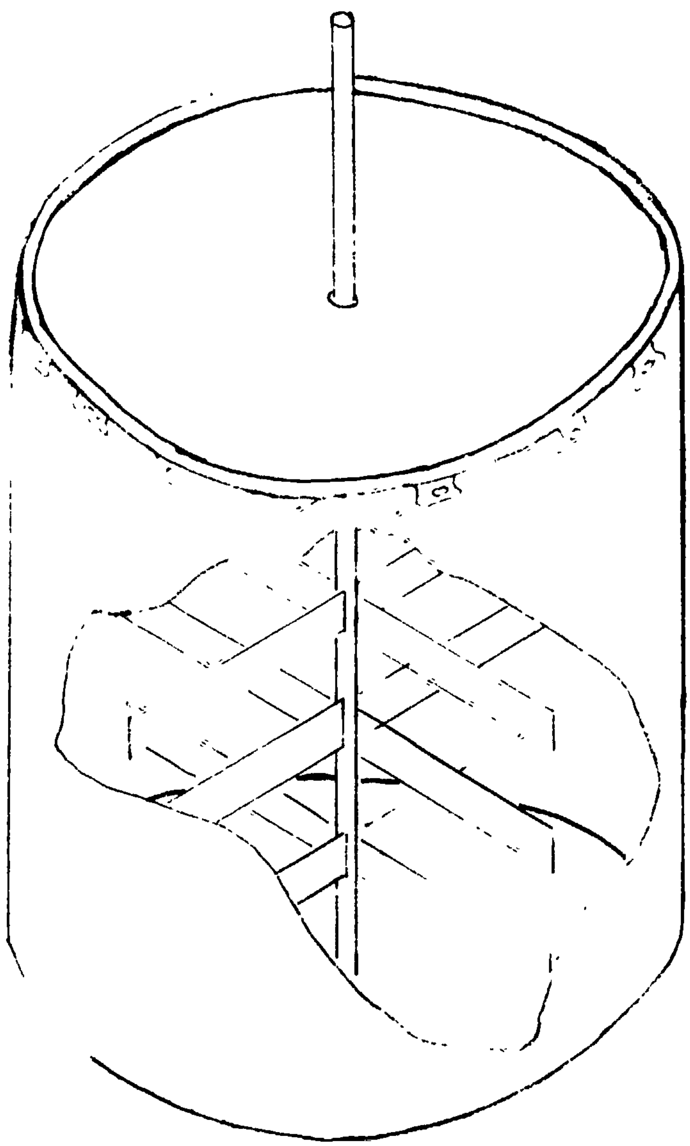
LIQUID WASTE INCINERATOR

MATERIALS - Tin - plate, fastened by spot welds, tubing, propane bottle.



HYDROSPOSAL UNIT

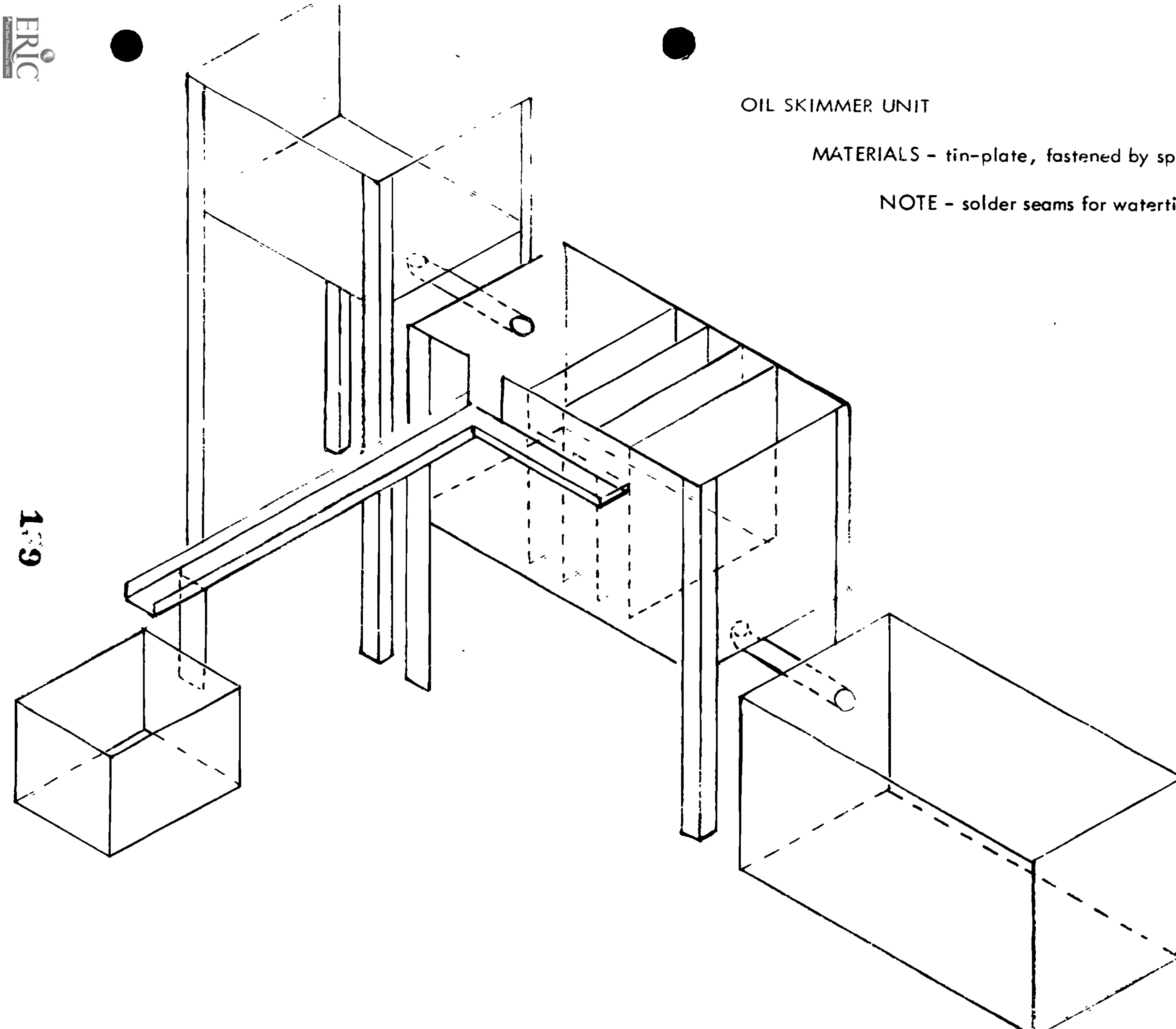
MATERIALS- five gallon pail, 1/2 " steel rod, band iron.



OIL SKIMMER UNIT

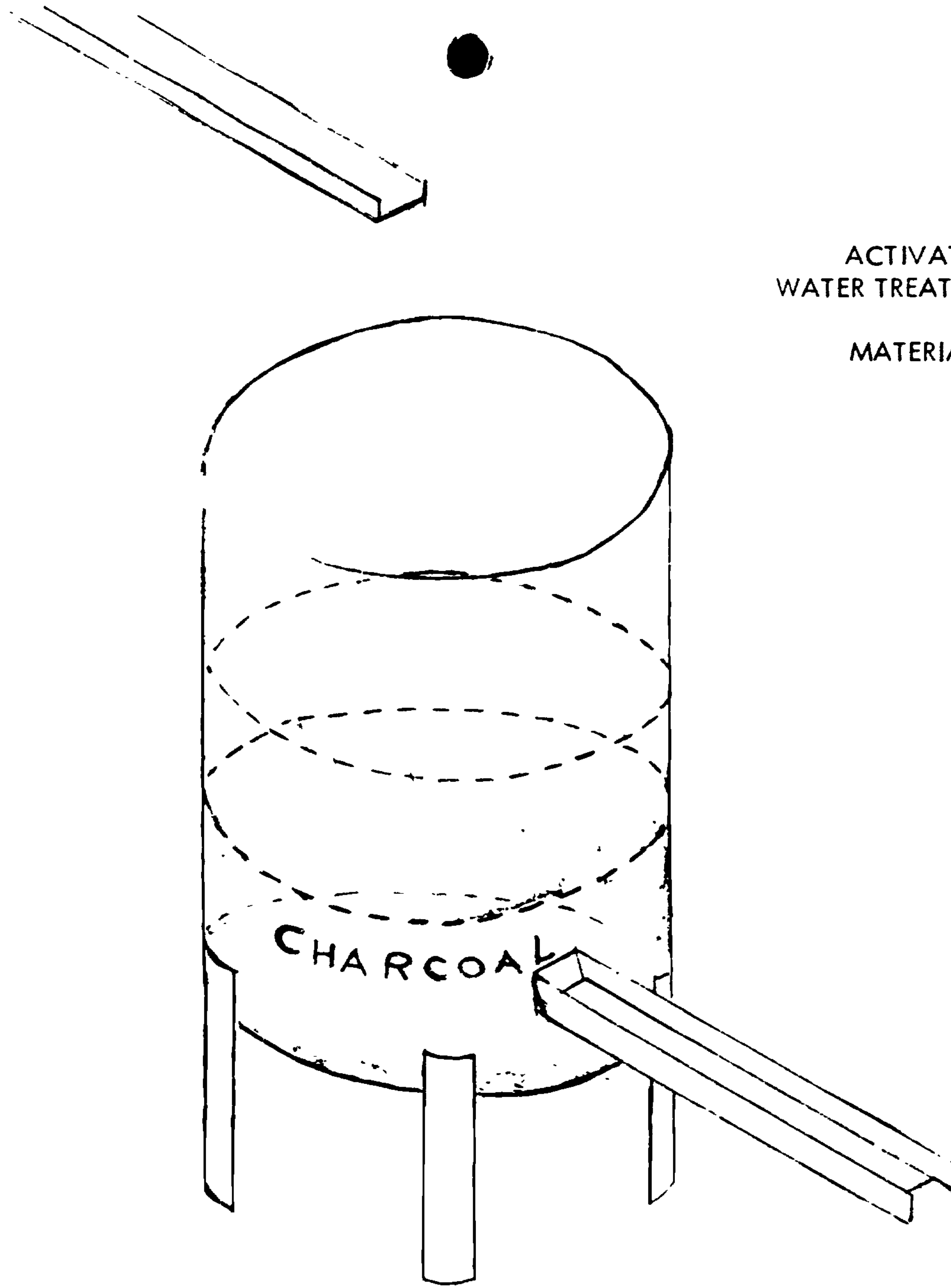
MATERIALS - tin-plate, fastened by spot welds.

NOTE - solder seams for watertightness!



ACTIVATED CHARCOAL
WATER TREATMENT UNIT

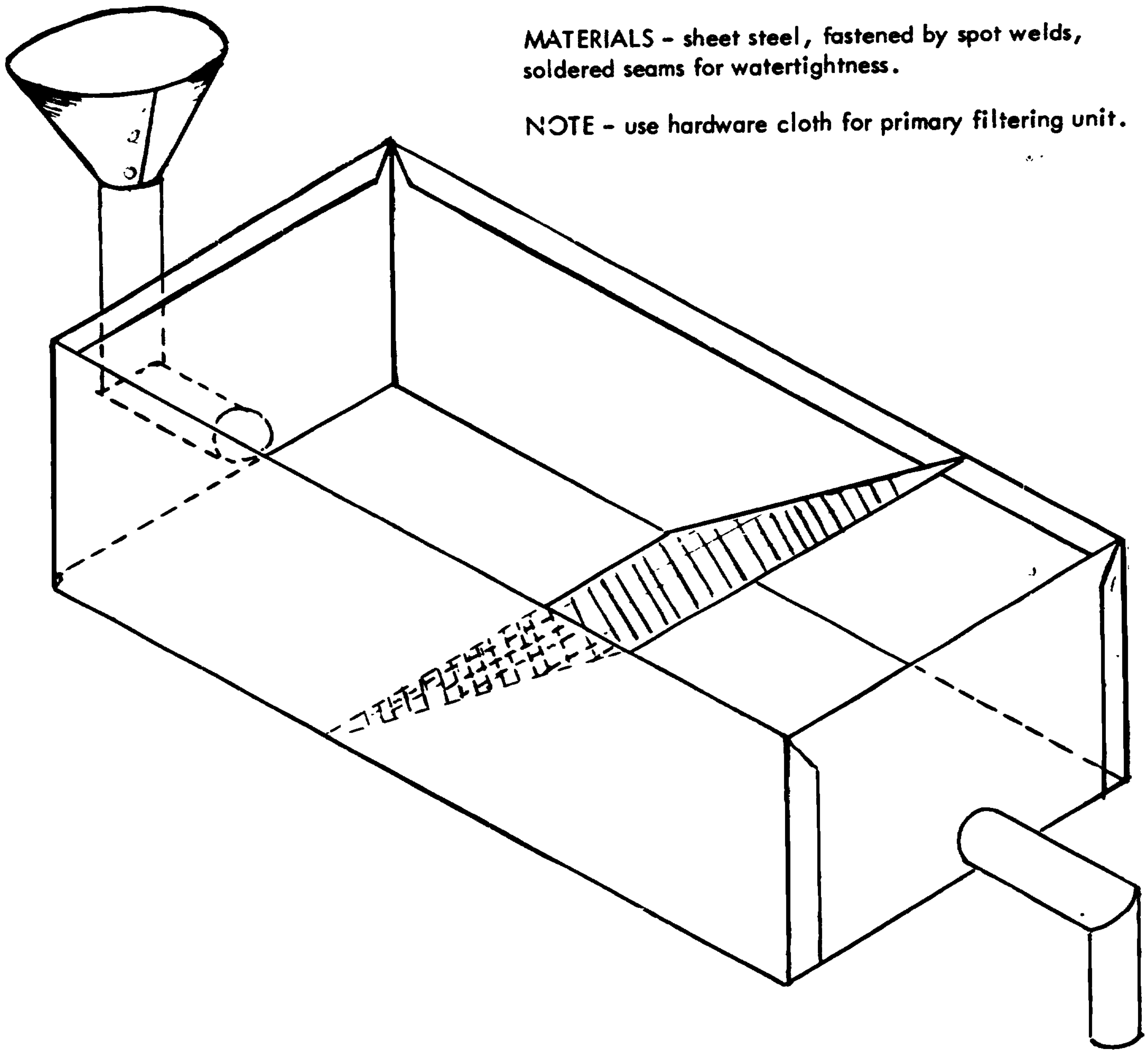
MATERIALS - sheet metal , 20 ga.
fastened by spot welds.

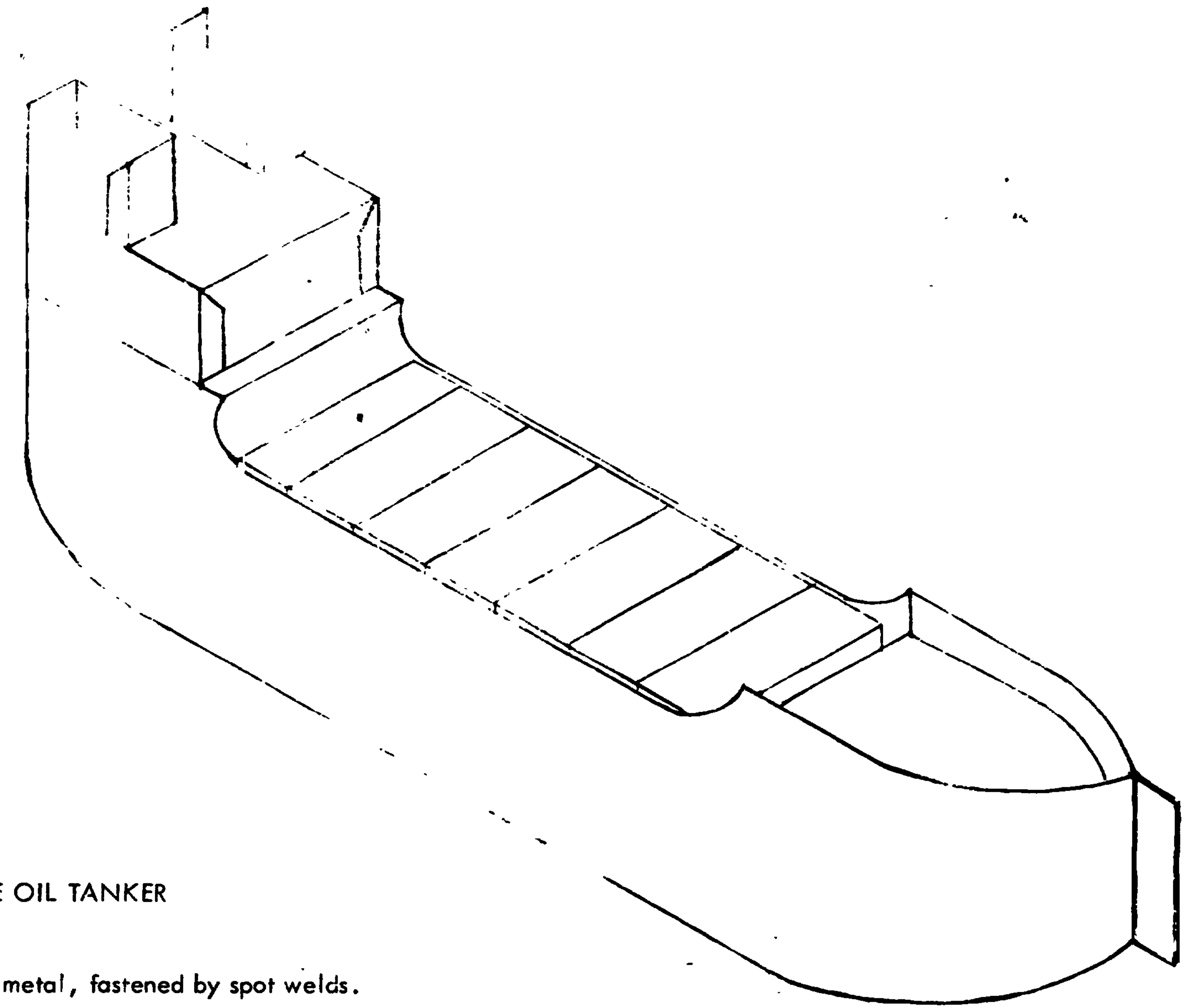


PRIMARY SEWAGE TREATMENT PLANT

MATERIALS - sheet steel, fastened by spot welds, soldered seams for watertightness.

NOTE - use hardware cloth for primary filtering unit.

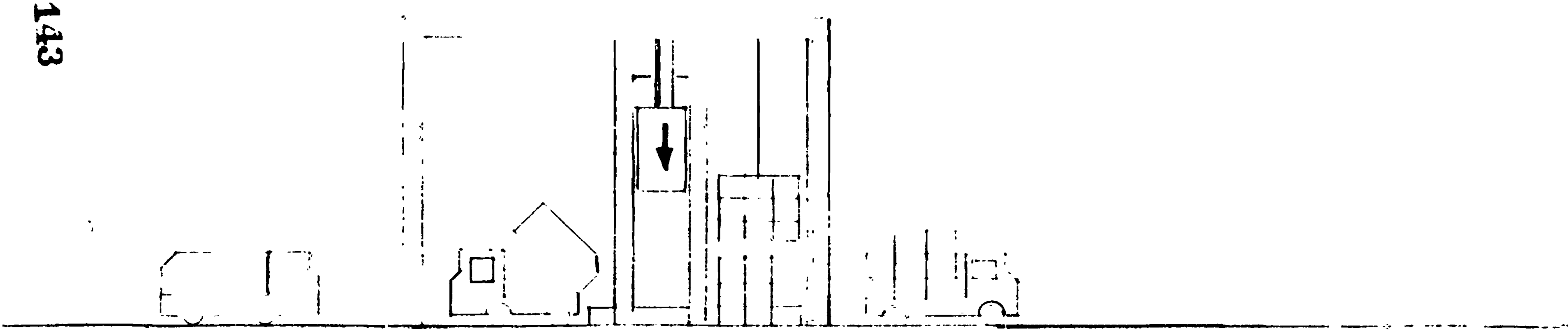




POLLUTION - FREE OIL TANKER

MATERIALS- sheet metal, fastened by spot welds.

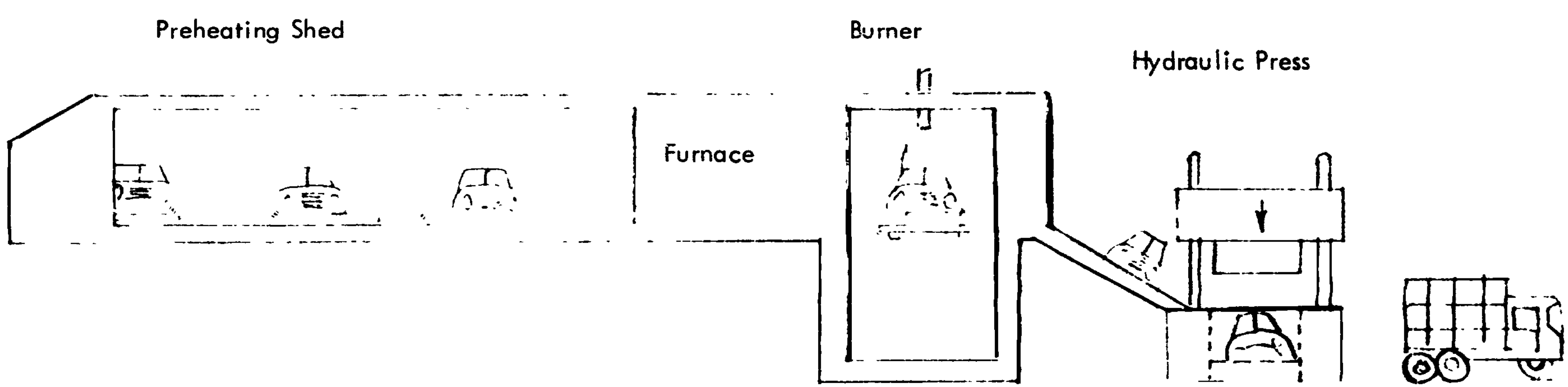
COMPRESSING GARBAGE INTO ROCKS



New Japanese plant produces a sterile, odorless building material. When coated with iron after compression, these blocks can be welded into place in such uses as building foundations and retaining walls.

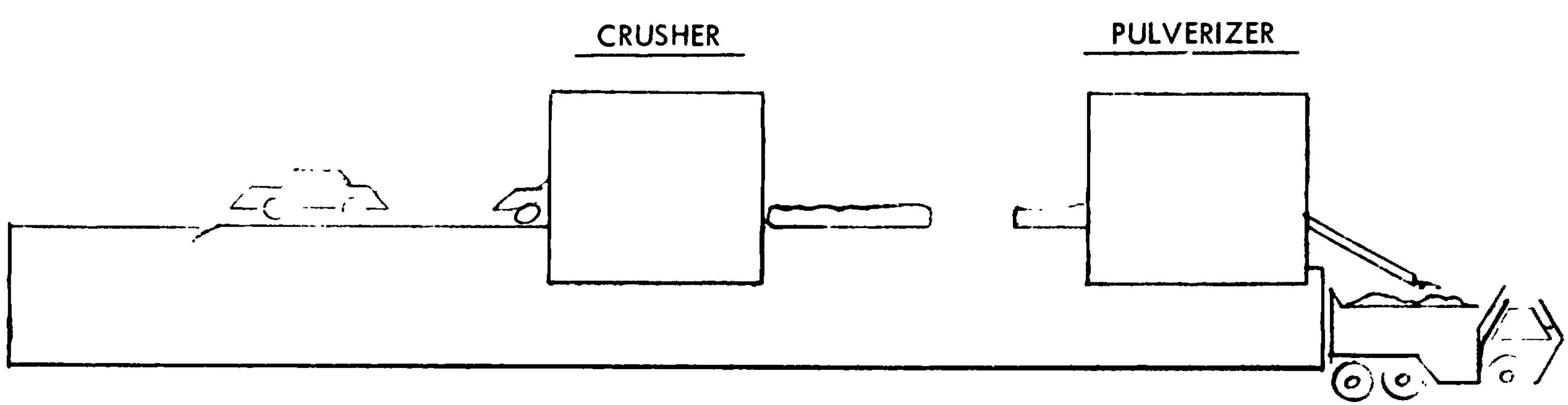
Product Engineering/October 9, 1967

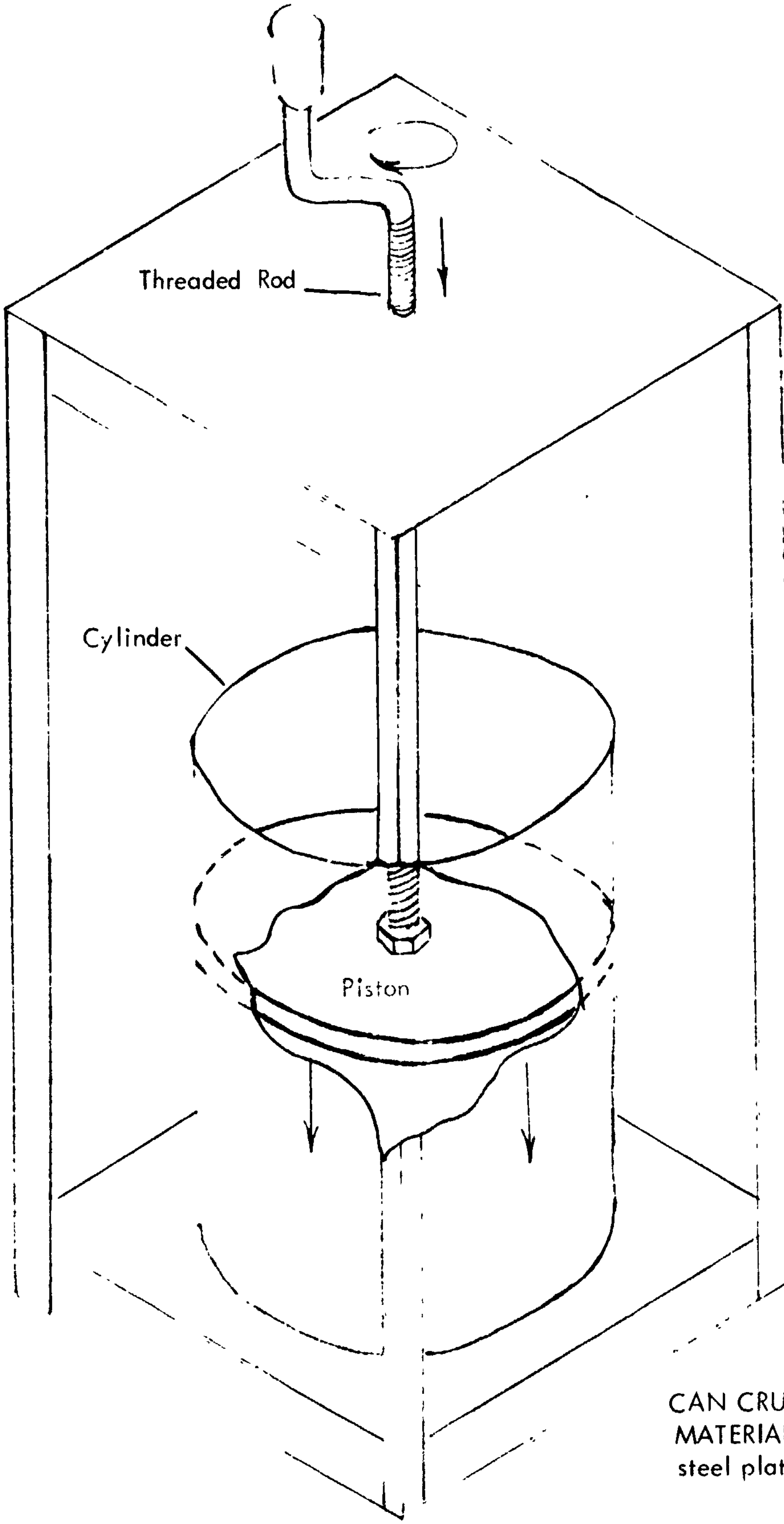
"Carbecue" plant in Japan cooks NONFERROUS metals successively out of JUNKED CARS for separate collection on trays. HYDRAULIC PRESS then crushes the ferrous hulk.



Product Engineering/October 9, 1967

CAR CRUSHER
MATERIALS - Plywood, card board, wood scraps

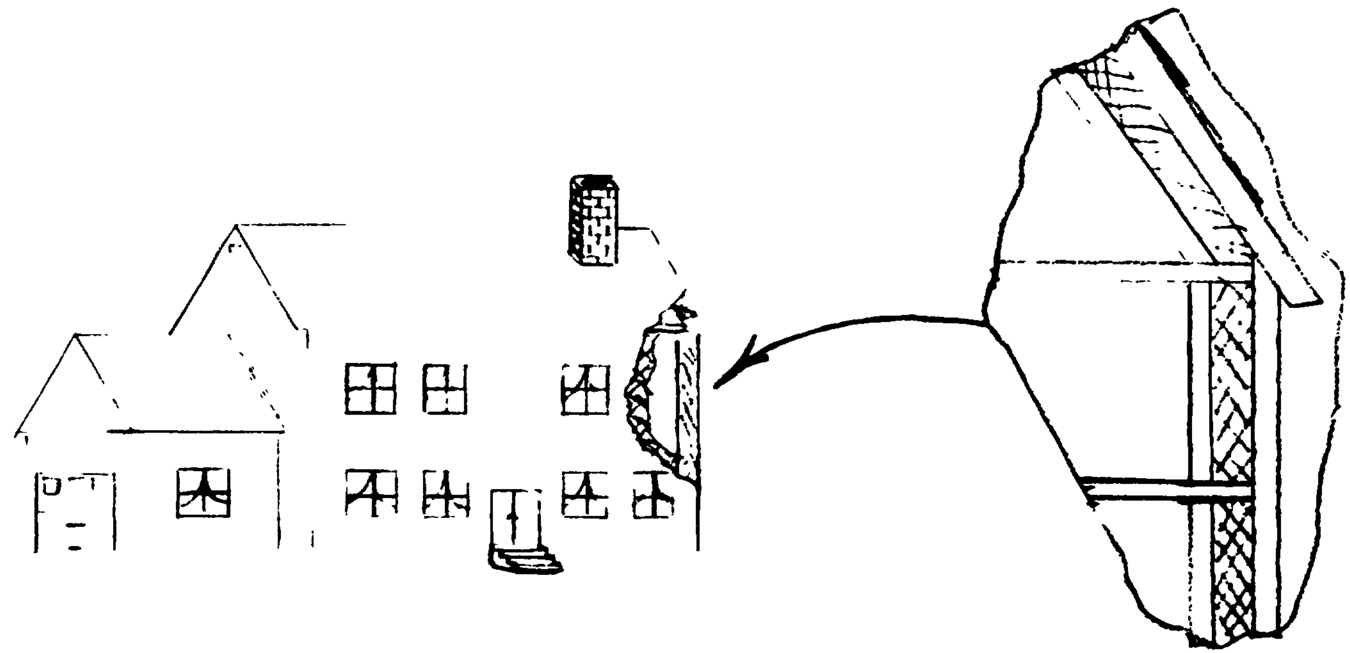




CAN CRUSHER
MATERIALS - band iron, steel plate, steel tubing

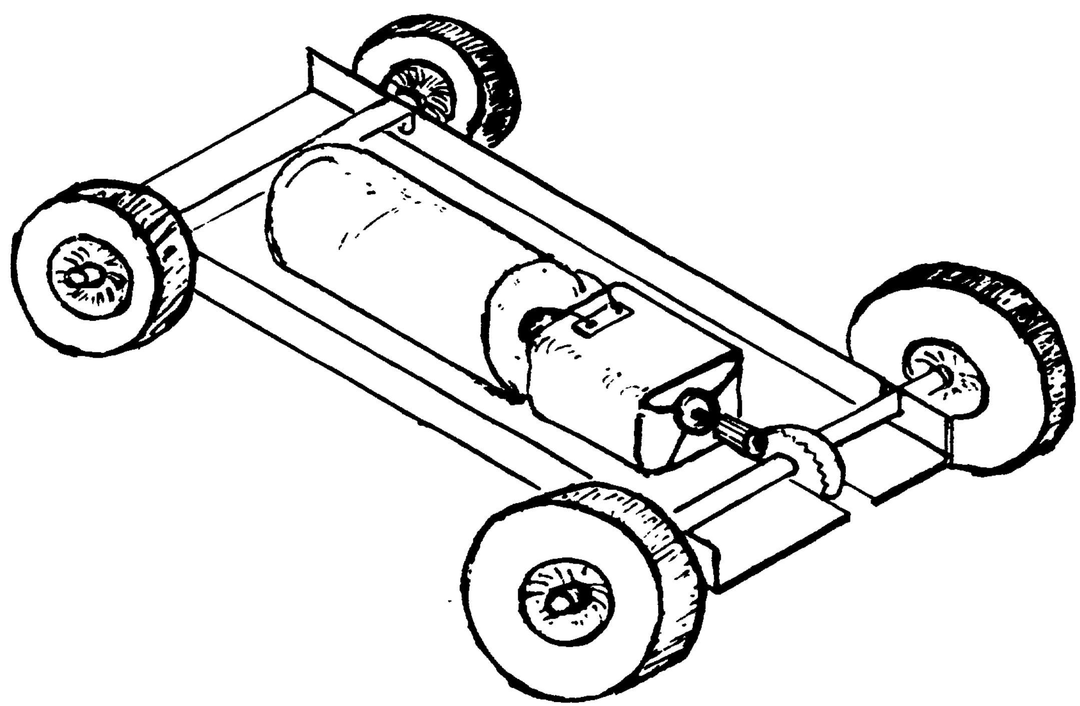
HOUSE INSULATED AGAINST NOISE

MATERIALS - plywood, card board, fiberglass insulation



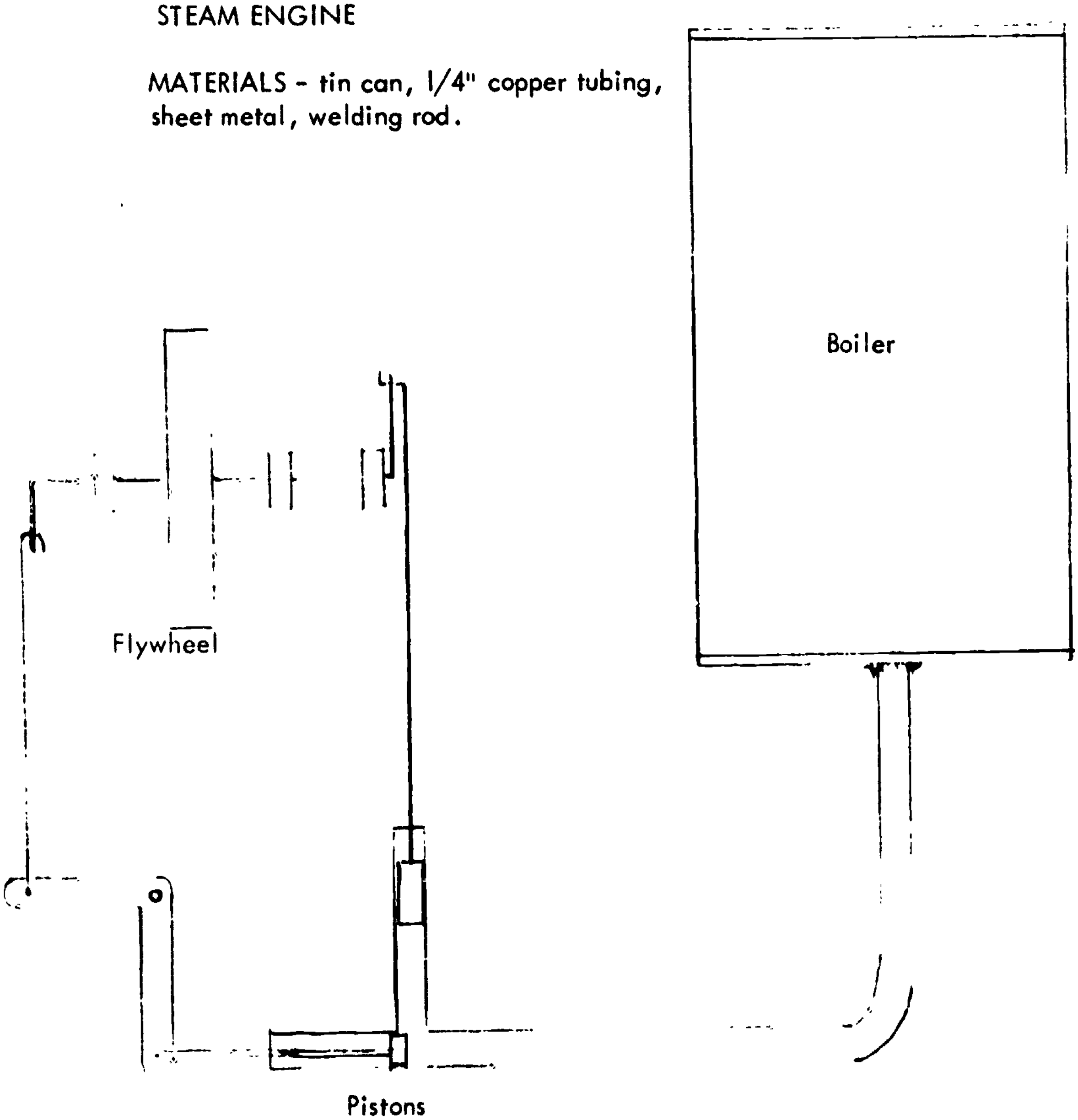
ELECTRIC CAR

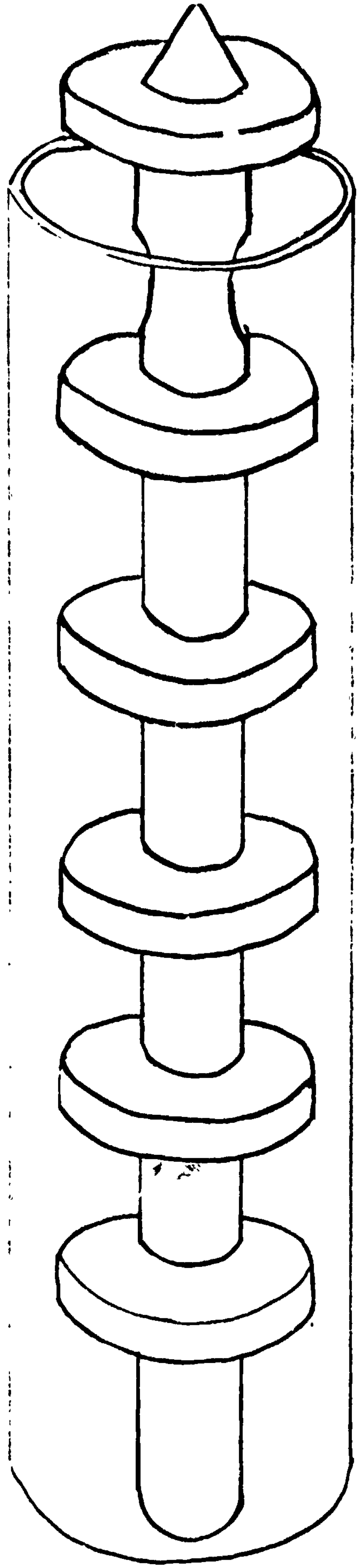
MATERIALS - sheet metal, parts from model cars



STEAM ENGINE

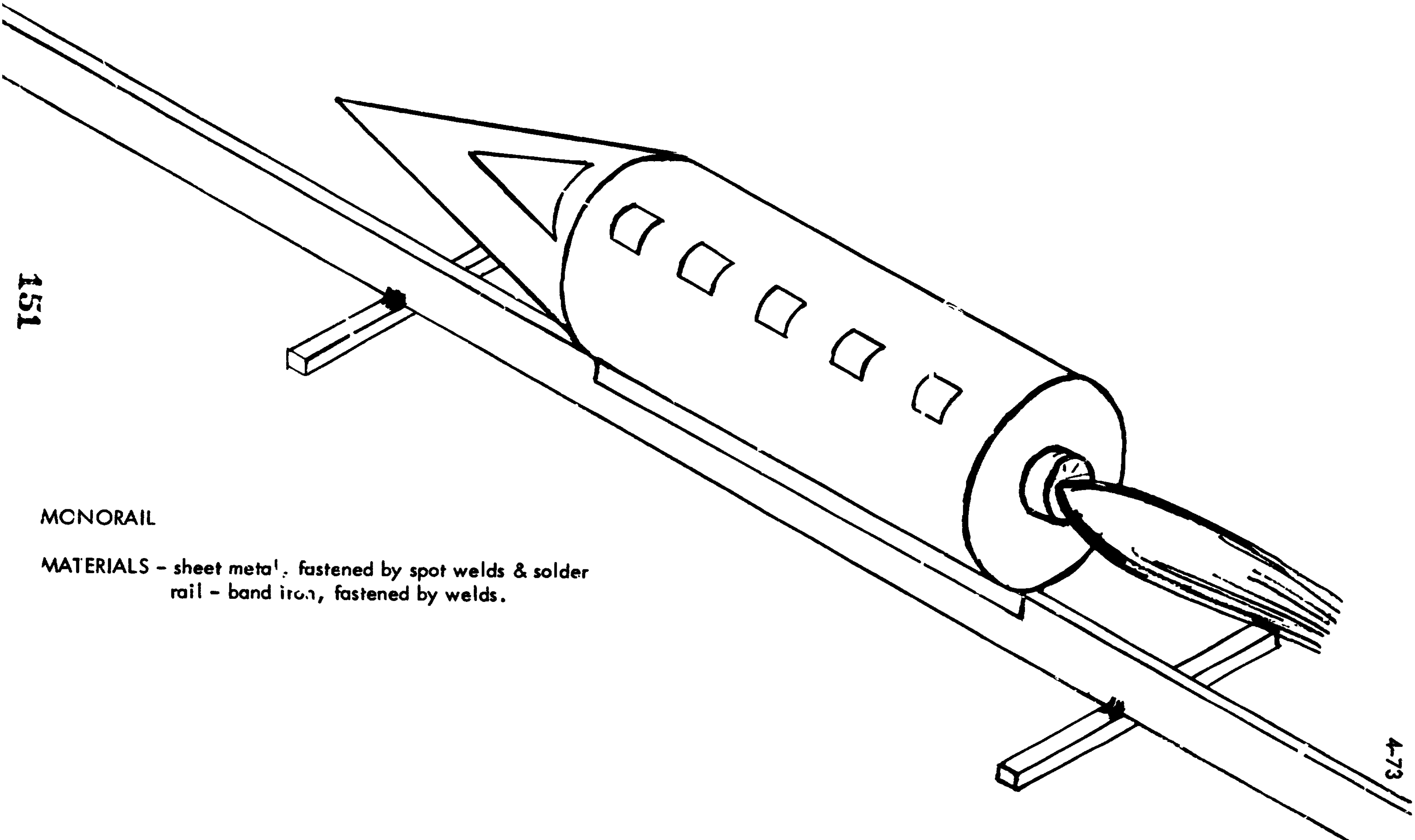
MATERIALS - tin can, 1/4" copper tubing, sheet metal, welding rod.





MODEL OF JET ENGINE

MATERIALS - pine turned on lathe, 1/32" acrylic sheet .

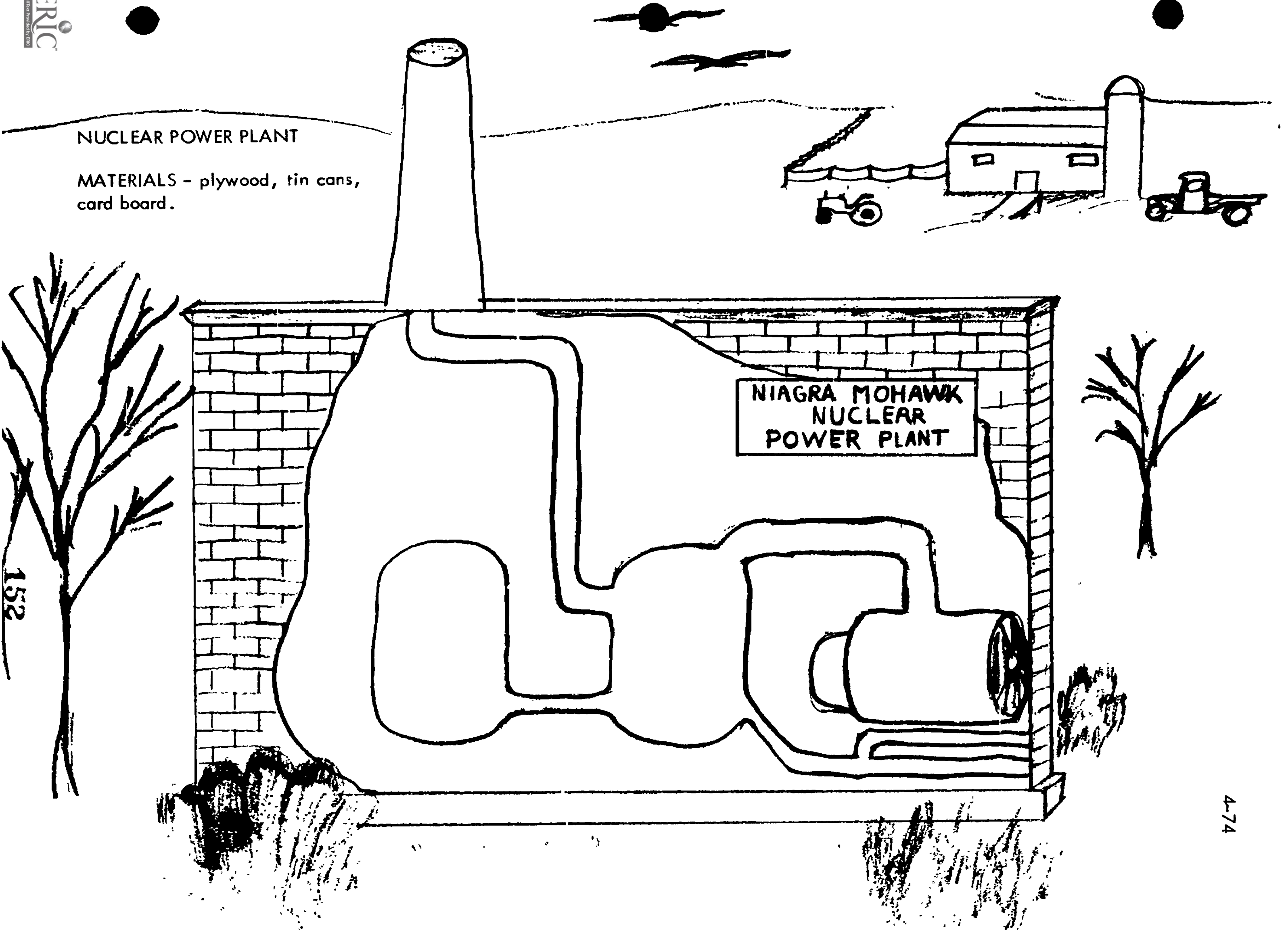


MONORAIL

MATERIALS – sheet metal, fastened by spot welds & solder
rail – band iron, fastened by welds.

NUCLEAR POWER PLANT

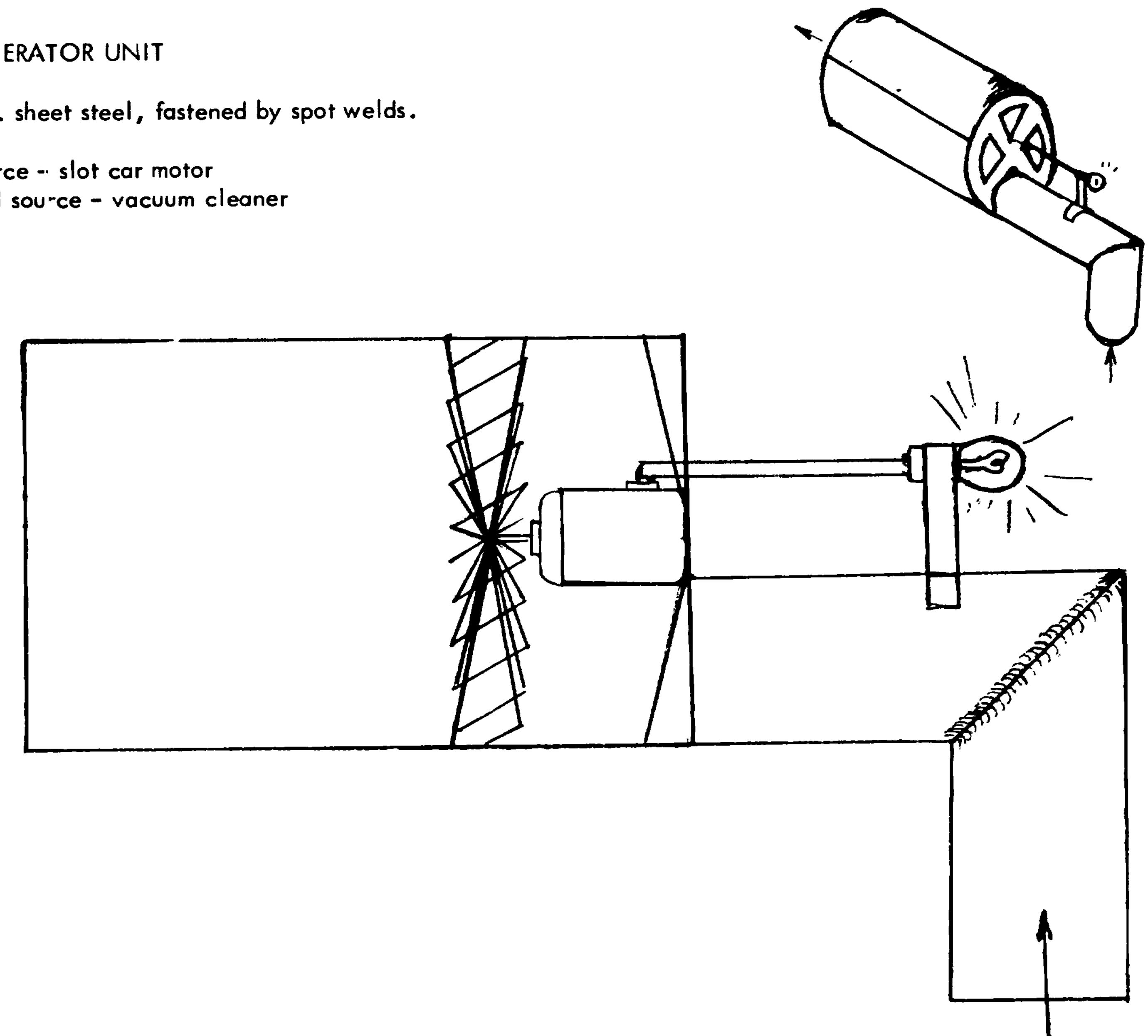
MATERIALS - plywood, tin cans, card board.



GEOTHERMAL GENERATOR UNIT

MATERIALS - 20 ga. sheet steel, fastened by spot welds.

NOTES - power source -- slot car motor
geothermal sou-ce - vacuum cleaner



SECTION 5

RESOURCES

RESOURCE TABLE OF CONTENTS

INTRODUCTION TO RESOURCES

The resource section of this package is designed to be useful to the instructor and the student in the development stages of the Industrial Ecology Program for the selection of materials. A wide range of topics and resources are available and will add insight to the problems and related solutions to industrial pollutants. Using these resources the instructor and the student will have up-dated information which will enhance and expand his work in the Industrial Ecology Program.

To supplement this information the instructor can use the telephone directory and the Thomas Register. As zip codes should be used a zip code guide book, available at the Post Office is necessary.

Public Utilities, airline companies and general industry have additional information and many times will send a guest speaker if requested by an instructor. These guest speaker are excellent for specific areas of pollution and the students respond very well.

RESOURCE CONTACT PEOPLE INVOLVED IN POLLUTION CONTROL

Air Pollution

Allied Chemical
Syracuse, N.Y.
Mr. Marcellous, Pers. Dir.

Crouse-Hinds Co.
Wolf and 7th North
Syracuse, N.Y.
Mr. R. Wachob, Mgr. of Facilities Engineer

Hammermill Paper Co.
Oswego, N.Y.
Mr. M. Herd

Oberdorffer Foundries
Thompson Rd.
Syracuce, N.Y.
Mr. Dwyer, Vice President

Pollution Abatement Services Of Oswego, N.Y.
East Seneca
Mr. J. Miller

Niagara Mohawk Power Corp.
Syracuse, N.Y.
Mr. J. Toennies, Environmental Eng.

Water Pollution

Carrier Co.
Carrier Circle
Syracuse, N.Y.
Attn: Pers. Dept.

Fisher Body
Syracuce, N.Y.
Attn: Pers. Dept.

(Water, Con't.)

Onondoga County Dept. Of Public Wks.
Div. Of Drainage and Sanitation
Hiawatha Blvd.
Syracuse, N.Y.
Mr. J. Swift or Mr. John Hennigan, Jr.
Deputy Commissioner

Syracuse Univ. College of Forestry
Syracuse, N.Y.
Dr. Robert Hennigan, Prof.

Lake Ontario Environmental Studies
S.U.N.Y. at Oswego
Piez Hall
Oswego, N.Y.
Dr. Moore, Prof., or Mr. P. Caplan

Pulaski Sewage Treatment Facilities
Pulaski, N.Y.
Mr. Von Hageman, Plant Operator

Schoeller Technical Paper Prod., Inc.
Personnel Off.
Pulaski, N.Y.
Attn: Mr. Mullen

Syracuse Univ. College of Forestry
Syracuse, N.Y.
Mr. David L. Taber, Prof.

Solid Pollution

Allied Chemical
Syracuse, N.Y.
Mr. Marcellous, Pers. Dir.

Carrier Company
Pers. Dir.
Carrier Circle
Syracuse, N.Y.

Fisher Body
Personnel Dept.
Syracuse, N.Y.

Gerry Mears, Supt. Laboratories and
Environmental Mgr.
Alcan Aluminum
Oswego, N.Y.

Oberdorffer Foundaries
Thompson Rd.
Syracuse, N.Y.
Mr. Dwyer, Vice President

Onondoga County Solid Waste Dept.
Onondoga County Off. Bldg.
S. State St.
Syracuse, N.Y.
Attn: Mr. R. Becker, Gen Mgr.

Oswego City Landfill
Oswego, N.Y.
Attn: Mr. Cook

Pollution Abatement Services of
Oswego, Inc.
East Seneca
Oswego, N.Y.
Mr. J. Miller

Spevake Waste Metals Co.
429 E. Hiawatha Blvd.
Syracuse, N.Y.
Mr. Fred Barr, Mgr.

Scoville Funeral Home
Cayuga St.
Oswego, N.Y.
Mr. Fred Scoville

U.S. Steel Corp.
600 Grant St.
Pittsburgh, Pa.
Attn: Mr. J. H. McGinty

INDUSTRIES & BUSINESSES WITH

ENVIRONMENTAL ANSWERS

ENVIRONMENTAL ENGINEERING SERVICES

Calgon Corp.
Subsidiary of Merck & Co., Inc.
Edgar G. Paulson
Technical Consultant
Environmental Group
Box 1346, Calgon Center
Pittsburgh, Pa. 15230

Lockwood Greene Engineers, Inc.
Herbert A. Schesinger, Manager
Pollution Control Department
230 Park Ave.
N. Y., N. Y.

Ford, Bacon & Davis, Inc.
William D. Bruce
Senior Vice-President
2 Broadway
N. Y., N. Y. 10004

Zurn Industries, Inc.
Bernard S. MacCabe
Group Vice-President
1422 East Ave.

AIR POLLUTION

Air conveying Co.
South Holland, Ill.

Air Maize Div.
North American Rockwell
Cleveland, Ohio

Air Pollution Ind., Inc.
701-T Palisade Ave.
Englewood, N. J. 07632

American Fir Filter
Louisville, Ky.

American Motors Corp.
14250 Plymouth Rd.
Detroit, Michigan

Automotive Manufacturers Associates, Inc.
320 New Center Bldg.
Detroit, Mich. 48202

Badger Meter Mfg. Co.
Saginaw, Mich.

Bon-Air Equipment
103 N. Beech
Syracuse, N. Y.
(475-9975)

Buell Engineering Co., Inc.
Lebanon, Pa.

Buffalo Forge Co.
Buffalo, N. Y.

Bufflovak Div.
Blaw-Knox Food & Chemical Equip. Co.
Buffalo, N. Y.

Calgon Corp.
Pittsburgh, Pa.

Caterpillar Tractor Company
Peoria, Ill. 61602
(Booklet "Transportation Crisis")

Cambridge Wire Cloth Co.
Cambridge, Md.

The Carborundum Co.
Niagara Falls, N. Y.

Carter-Day Co.
Minn., Minn.

Catalytic Inc.
Philadelphia, Pa.

Celcote Co.
Berea, Ohio

Chrysler Corp.
343 Massachusetts Avenue
Detroit, Michigan

Crane Co.
Environmental Systems Division
King of Prussia, Pa.

DeLaval Seperator Co.
Poughkeepsie, N. Y.

Derrick Mfg. Corp.
Buffalo, N. Y.

DeVilbiss Co.
Toledo, Ohio

Dopp Systems Inc.
Whitestone, N. Y.
(Automobile catalytic converter)

Dravo Corp.
Pittsburgh, Pa.

Ecology Leasing Corp.
Lake Success, N. Y.

Ecological Resources
New York, New York

E. I. DuPont de Nemours & Co.
Wilmington, Deleware

Englehard Minerals & Chemicals
Newark, N.J.

Envirotech Corp.
Palo Alto, Calif.

Fly Ash Arrester Corp.
Air Systems Div., Zurn Ind. Inc.
277 N 1st
Birmingham, Alabama

Ford Div., Ford Motor Co.
Rotum
Dearborn, Mich. 48124

J. E. Heywood, Chief Research Eng.
Ford Div., Ford Motor Co.
Rotunda & Southfield
Dearbom , Mich.

Fuller Co.
Catasauqua, Pa.

General Electric Co.
New York

General Motors Corp.
General Motors Bldg.
Detroit, Mich.

The Hasselberg Co.
Buffalo, N. Y.

Heil-Process Equipment Corp.
Cleveland, Ohio

Herrick Geo. S. Grate Co.
110 Liberty
Syracuse, N. Y. (wet scubbers)

IPCI International Pollution Control, Inc.
Houston, Texas.

Jenssen G D Co. Div.
359 Easter Blvd.
Watertown N. Y.
(gas washer, acid tower)

Johns - Manville
New York

Keene Corp.
Water Pollution Control Div.
Aurora, Ill.

Koppers Co., Inc.
Pittsburgh, Pa.

The Marley Co.
Kansas City, Mo.

Marotta Scientific Controls Inc.
Boonton, N. J.

Millipore Corp.
Bedford, Mass.

Mixing Equipment Co.
Rochester, N. Y.

Monsanto Co.
St. Louis, Mo.

Precipitair Pollution Control Inc.
Bound Brook, N. J.

Pulverizing Machinery
Div. of The Slick Corp.
Summit, N. J.

Peabody Engineering Corp.
234 Madison Ave.
NY., N. Y.
(scubber, absorber)

Sargent NCV Div., Zurn Ind. Inc.
608 Devon
Kearny, N. J.

Seversky Electron Atom Corp.
One de Seversky Plaza
Garden City, N. Y.
(air pollution control system)

Syrall Mfg. Co., Inc.
319 N Salina
Syracuse, N. Y.
(Incineration)

Research/Cottrell, Inc.
Bound Brook, N. J.

Rheem Mfg. Co.
New York, N. Y.

Ross Engineering Div.
Midland-Ross Corp.
New Brunswick, N. J.

Rotodyne Mfg. Corp.
Brooklyn, N. Y.

The Rust Engineering Co.
Pittsburgh, Pa.

The Trane Co.
La Crosse, Wisc.

UOP Air Correction
Darien, Conn.

Universal Oil Products Co.
Desplains. Ill.
(Automobile catalytic Converter)

Vitrol Corp.
Belmont, Calif.
(Scrubber)

Western Precipitaton Div.
Joy Mfg. Co.

Westinghouse Electric Corp.
Pittsburgh, Pa.

Wheelabrator Corp.
Mishawaks, Ind.

Zurn Ind., Inc.
Erie, Pa.

CHEMICAL POLLUTION

E. I. Dupont de Nemours & Company, Inc.
Wilmington, Del.
(Booklets, " toward a Better Environment, 1970", and " Company Community: The Responsibility of Business In the Society, 1967)

Manufacturing Chemists Association
1835 Conn. Ave.
Washington, D.C. 20009

MASS TRANSPORTATION

Baltitronic Truck Corp.
Boyertown, Pa.
(battery powered bus)

Wabco Monorail Div.
Westinghouse Air Brake Co.
Bldg. #8 Cape May County Airport
Rio Grande, N.J. 08242
(monorail)

NOISE POLLUTION

Aeromotive Designers Inc.
26951 Tungsten
Cleveland, Ohio

Colt Industries Inc.
Chandler Evans Control Systems Div.
West Hartford, Conn.

E. Duane Stone, Plant Engineer
Cessna Aircraft Co.
P.O. Box 1877
Wichita, Kansas 67201

Goodwin Engineering Corp.
7-T North 2nd Ave.
Maywood, Ill.

Ingersoll-Rand
N.Y., N.Y.

Parker Aircraft
5827 West Century Blvd.
Los Angeles, Calif.

RADIATION POLLUTION

Doyle & Roth Mfg. Co., Inc.
136 Liberty St.
N.Y., N.Y. 10006

General Electric Co.
1 River Rd.
Schenectady, N.Y.

General Nuclear Corp.
550-4 Fifth Ave.
New York, N.Y.

Newbrook Machine Corp.
Nuclear Hardware Div.
1213 Mechanic St.
Silver Creek, N.Y.

Nuclear Technology Corp.
333 Old Tarrytown Rd.
White Plains, N.Y.

Platecoil, Division of Tanter Mfg. Inc.
705 E Hazel
Lansing, Mich.

United Nuclear Corp.
Grassland Rd.
Elmsford, N.Y.

SEWAGE POLLUTION

The Bower Bros. Co.
Springfield, Ohio.
(screening raw sewage)

Con-Tex Industries
Mineral Wells, Texas
("Understarding the World of Sewage")

General Filter Co.
Ames, Iowa
(Waste water treatment)

Lamere Ind., Inc.
Walworth, Wisc.

Peabody Water Resources-Hart
Newington, Conn.
(waste water Plants)

SOLID POLLUTION

American Bag & Metal Co., Inc.
400 Spencer
Syracuse, N.Y.

American Solid Waste System
Division of American Hoist and Deric Co.
St. Paul, Minn.

Balderson Inc.
Wamego, Kan.
(landfills)

Bauer Bros. Co., Springfield, Ohio

Betz Laboratories Inc.
Trevose, Pa.

Buell Engineering Co., Inc.
Lebanon, Pa.

Black Clawson Co.
Middletown, Ohio

Buftalo Forge Co,
Buffalo, N. Y.

Bufflovak Div.
Blaw-Knox Food & Chemical Equipment Inc.
Buffalo, N. Y.

Cadillac Plastic and Chemical Co.
2700 Erie Blvd. East
Syracuse, N. Y.

Calgon Corporation
Pittsburgh, PA.

The Carborundum Co.
Niagara Falls, N. Y.

Combustion Engineers Inc.
Chicago, Ill.

Carter-Day Co.
Minneapolis, Minn.

Crane Co.
Enviromental Systems Div.
King of Prussia, Pa.

Dempster Bros. Inc.
Knoxville, Tenn.

Derrick Mfg. Corp.
Buffalo, N. Y.

Dow Chemical Co.
Midland, Michigan

Dubois Chemicals Inc.
Cinncinnati, Ohio

E. I. DuPont de Nemours & Co.
Wilmington, Deleware

Ecology Resources
New York

Ecology Leasing Corp.
Lake Success, N. Y.

Elgin Softener, Inc.
Elgin, Ill.

Envirotech Corp.
Palo Alto, Calif.

W. R. Grace & Co.
Chicago, Ill.

Helix Corp.
Crown Point, Indiana
(Refuse Truck Unit- Packing Unit)

Hercules Inc.
Wilmington, Deleware

Ionics, Inc.
Bridgeville, Pa.

Jeffery Manufacturing Co.
Dept. SW-117
970 N. 4th St.
Colombus, Ohio
(Shredder and pulverizer)

Kopper Co., Inc.
Pittsburgh, Pa.

The Heil Co.
3000 W. NMontana St.
Milwaukee, Wisc. 53201

Hoist and Derrick Co.
63 S Robert St.
St. Paul, Minn. 55107
(solid waste baler)

Lindig Manuf. Corp.
St. Paul, Minn.
(Recycle leaves and such to topsoil and mulch)

Little, Inc.
Cambridge, Mass.

Mapco, Inc.
Tulsa, Okla.

Marotta Scientific Controls, Inc.
Boonton, N. J.

Millipore Corp.
Bedford, Mass/

Mixing Equipment Co.
Rochester, N. Y.

Monsanto Co.
St. Louis, Mo.

Midwest Rubber Reclaiming Co.
P. O. Box 744
E St. Louis, Ill. 62202

Mozemag Inc.
P. O. Box 1064
Uniontown, Pa.
(Refuse crusher)

Nalco Chemical Co.
Chicago, Ill.

Oxy-Catalyst Inc.
West Chester, Pa.

Pak-Mor Manufacturing Co.
P. O. Box 14147
San Antonio, Texas

Plastics Research & Consulting
Gulles Associates
3650 James
Syracuse, N. Y.

Pollution Control Industries, Inc.
Stamford, Conn.

Pollution Preventers Inc.
2625 S. Salina
Syracuse, N. Y. (478-0428)

Procon Inc.
Des Plaines, Ill.

Pulverizing Machinery
Div. of Slick Corp.
Summit, N. J.

Rampmaster Inc.
Ft. Lauderdale, Fla.
(portable baler)

Research/Cottrell Inc.
Bound Brook, N. J.

Rex Chainbelt, Inc.
Milwaukee, Wisc.

The Rust Engineering Co.
Pittsburgh, Pa.

Solid Waste Management
King of Prussia, PA.

Technicon Corp.
Tarrytown, N. Y.

Telsmith, Div. of Bor-Ber-Greene
Milwaukee, Wisc.
(glass disposal problem)

Trios Plastics Corp.
543 Tarrytown Rd.
White Plains, N.Y. 10607
(custom plastic packaging)

Vibra Screw Inc.
Totowa, N.J.

Western Precipitator Div.
Joy MFG. Co.

Wheelabrator Corp.
Mishawakas, Ind.

Witco Chemical Corp.
New York

Zurn Industries Inc.
Erie, Pa.

WATER POLLUTION

ABC Oil and Acid Removal
711- S West
Syracuse, N.Y.
(467-1188)

ASC Mfg. Co., Inc.
Dept TR 565 5th Ave
N.Y., N.Y.

Airco Industrial Gases, Inc.
Murray Hill, N.J.

Air Preheater Co., Inc.
Wellsville, N.Y.

Alpha Engineering Research
Box 242-TR
Bud Lake, N.J.

Aqua-Chem. Inc.
Milwaukee, Wisc.

Atlantic Richfield Co.
717 Fifth Ave.
N.Y., N.Y.

Atlas Chemical Ind. Inc.
Wilmington, Del.

Badger Meter Mfg. Co.
Saginaw, Mich.

Belco Pollution Control Corp.
100 Penn.
Patterson, N.J.
(cooling control plants)

BIFI Unit of General Signal Corp.
346 Harris Ave
Province, R.I. 02901

Biodize Systems Inc.
Great Neck, N.Y.

Black Clawson Co.
Middletown, Ohio

The Boeing Co.
P.O. BOX 3707
Seattle, Wash. 98124
(hydrofoil)

Bethlehem Steel Corp.
Shipbuilding Div.
25 Broadway
N.Y.,, N.Y.

Buffalo Forge Co.
Buffalo, N.Y.

Bufflovak Div.
Blaw-Knox Food & CHemical Equip. Inc.
Buffalo, N.Y.

Calgon Corp.
Pittsburgh, Pa.

Can-Tex Waste Treatment Systems
Stevens J. W. Co., Inc.
320 Tracy
Syracuse, N.Y.

The Carbo undum Co.
Niagara Falls, N.Y.

Carver-Greenfield Corp.
9-T Great Meadow Lane
East Hanover, N.J.

Carter-Day Co.
Minneapolis, Minn.

Catalytic Inc.
Philedelphia, Pa.

Chem-Trol Pollution Services Inc.
4818 Lake Ave. Blasdell
Syracuse, N.Y.

Chicago Sewage & Ind. Waste Treatment Equip.
Mac Crea Assoc. Inc.
153 Oakland
Syracuse, N.Y.

Clow Corp.
Chicago, Ill.

Cochran Ind. Water Tretment Equip.
520 Charles Ave.
Syracuse, N.Y.

Crane Co.
Environmental Systems Div.
King of Prussia, Pa.

Culligan Inc.
South Shermer Rd.
Northbrook, Ill. 60062

DeLaval Seperator Co.
Poughkeepsie, N.Y.

Derrick Mfg. Corp.
Buffalo, N.Y.

Dicalite Div. Grefco, Inc.
Los Angeles, Calif.

Door-Oliver Inc.
Stamford, Conn.

Dravo Corp.
Pittsburgh, Pa.

Ecology & environment Inc.
195 Sugg Rd.
Cheektowaga, N.Y.

Ecology Resources
N.Y.

Ecology Leasing Corp.
Lake Success, N.Y.

Elmco Corp.
Salt Lake City, Utah

Enviro-Chem Systems, Inc.
St. Louis,

Envirotech Corp.
Palo Alto, Calif.

Environmental Services, Inc.
York, Pa.

Ethyl Corp.
Flocor Div.
Baton Rouge, La.

Elliot Co., Div. of Carrier Corp.
Jeanette, Pa.

Environ Laboratories Inc.
9725 Girad Ave

Environmental Services
1319 Mount Rose Ave.
York, Pa.

Envirotech Corp.
4455 Genesee
Syracuse, N.Y.

Foxboro Co.
Foxboro, Mass.

French M J Co., Inc.
680 Ridge Rd.
Webster, N.Y.

Fuller Co.
Catasauqua, Pa.

Galso Technical Services Inc.
6601 Kirkville Rd.
E Syracuse, N.Y.

General Electric Co.
Technical Services Laboratory
Electronic Pk.
Syracuse, N.Y. 13201

W. R. Grace Co.
7 Hanover Square
N.Y., N.Y. 10005

Grafton Boat Co.
Grafton, Ill.
(Harbor Clean Up Vessel)

Graver Water Conditioning Co.
Union, N.J.

Haveg Industries, Inc.
Wilmington, Del.

Hercules Inc.
Wilmington, Del.

Horton Process Division
Chicago Bridge and Iron Co.
Oak Brook, Ill 60521

Illinois Water Treatment Company
280 Madison Ave.
N.Y., N.Y.

Ingersoll-Rand
New York

Ionics, Inc.
Bridgeville, Pa.

Johns-Manville
N.Y.

Keene Corp. Water Pollution
Control Div.,
Aurora, Ill.

Ladish Co.
Kenosha, Wisc.

Leeds and Northrop
North Wales, Pa.

Link Belt, FMC Corp.
Chicago, Ill.

Marrotta Scientific Controls
Boonton, N.J.

Mixing Equipment Co.
Rochester, N.Y.

Monsanto Co.
St. Louis,

Nalco Chemical CO.
Chicago, Ill.

Pacific Engineering & Production
Co. Of Nev
Henderson, Nevada
(Electrolytic Waste Water treatment)

Penwalt Corp.
Warminster, Pa.

Permutit Co.
Paramus, N.J.

Pfaudler, Co.
Rochester, N.Y.

Pollution Control Construction Inc.
5123 Marcellus Fall Rd.
Camillus, N.Y.

Pollution Control Industries
Sta

Potter & Rayfield
Atlanta, Ga.

Procon Inc.
Des Plaines, Ill.

Pulverizing Machinery
Div. of The Slick Corp.
Summit, N.J.

Reeves Brothers, Inc.
New York

Rex Chainbelt, Inc.
Milwaukee, Wisc.

Rheem Mfg. Co.
N.Y., N.Y.

Technicon Corp.
Tarrytown, N.Y.

Walker Water and Waste Treatment Equip.
Div. of Chicago Bridge and Iron Co.
Aurora, ILL. 60506

Western Filter Co.
Denver, Colo.

Western Precipitator Div.
Joy Mfg. Co.

Westinghouse Electric Corp.
Pittsburgh, Pa.

Worthington Corp.
Harrison, N.J.

Zurn Industries Inc.
Erie, Pa.

Government Agencies

Bureau of Reclamation
Attn: 801 Bldg. 67
Denver Federal Center
Denver, Colo.

U.S. Environmental Protection Agency
Cinncinnati, Ohio
also
Office of Public Affairs
Washington, D.C. 20460

Federal Water Pollution Control Ass.
633 Indiana Ave. SW
Washington, D.C. 20242

Federal Water Quality Admin.
North east Regional Off.
John F. Kennedy Federal Bldg.

National Air Pollution Control Admin.
801 Randolph St.
Arlington, Va. 22203

Onondoga Solid Waste Authority
Syracuse, N.Y.

Public Inquiries Unit
Off. of Public Information
United Nations Bldg.
N.Y., N.Y. 10017

U.S. Atomic Energy Commission
Technical Information
Oak Ridge, Tenn. 37830

U.S. Dept. of Commerce
Environmental Science Services Admin.
Off. of Public Information Attn: ESSA - PI
Teaching Materials
Rockville, Md. 20852

U.S. Dept. of Health - Public Inquiries Branch
Dept. of Health, Education and Welfare
Washington, D.C. 20201

U.S. Dept. of State
Bureau of Public Affairs
Washington, D.C. 20520

State Water Pollution Control Agencies

Illinois Environmental Protection Agency
535 West Jefferson Street
Springfield, Illinois 62706

ALABAMA
Water Improvement Commission
State Office Building
Montgomery, Alabama 36104

ALASKA
Alaska Dept. of Health & Welfare
Alaska Office Building
Juneau, Alaska 99801

ARIZONA
Environmental Health Service
Department of Health
Hayden Plaza West
4019 North 33rd Avenue
Phoenix, Arizona 85017

ARKANSAS
Arkansas Pollution Control Comm.
1100 Harrington Avenue
Little Rock, Arkansas 72202

CALIFORNIA
State Water Resources Control Board
1416-9th St
Sacramento, California 95814

COLORADO
Department of Public Health
4210 East 11th Avenue
Denver, Colorado 80220

CONNECTICUT
State Water Resources Commission
Room 223, State Office Building
Main Street
Hartford, Connecticut 06115

DELAWARE
Delaware Air and Water Resources Commission
Loockerman Street and Legislative Avenue
Dover, Delaware 19901

DISTRICT OF COLUMBIA
District of Columbia Department of Public Health
300 Indiana Avenue, N.W.
Washington, D. C. 20001

FLORIDA
Dept. of Air and Water Pollution Control
315 South Calhoun Street
Tallahassee, Florida 32301

GEORGIA
State Water Quality Control Board
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

GUAM
Guam Water Pollution Control Commission
P O Box 2999
Agana, Guam 96910

HAWAII
Environmental Health Division
Hawaii Dept. of Health
P. O. Box 3378
Honolulu, Hawaii 96801

IDAHO
Engineering & Sanitation Div.
State Department of Health
P. O. Box 640
Boise, Idaho 83701

ILLINOIS
[redacted]
Stream Pollution Control Board
1330 West Michigan Street
Indianapolis, Indiana 46207

IOWA
Water Pollution Division
State Department of Health
Lucas State Office Building
Des Moines, Iowa 50319

KANSAS
Environmental Health Services
State Department of Health
Topeka Avenue at Tenth
Topeka, Kansas 66612

KENTUCKY
Kentucky Water Pollution Control Comm.
275 East Main Street
Frankfort, Kentucky 40601

LOUISIANA
Louisiana Stream Control Commission
P. O. Drawer FC, University Station
Baton Rouge, Louisiana 70803

MAINE
Water and Air Environmental Improvement Commission
State House
Augusta, Maine 04330

MARYLAND
Environmental Health Services
State Department of Health
2305 N. Charles Street
Baltimore, Maryland 21218
and
State Dept. of Water Resources
State Office Building
Annapolis, Maryland 21401

MASSACHUSETTS
Division of Water Pollution Control
Department of Natural Resources
100 Cambridge Street
Boston, Massachusetts 02202

MICHIGAN
Water Resources Commission
Stevens T Mason Building
Lansing, Michigan 48926

MINNESOTA
Minnesota Pollution Control Agency
717 Delaware St., S.E.
Minneapolis, Minnesota 55440

MISSISSIPPI
Mississippi Air and Water Pollution Control Commission
P. O. Box 827
Jackson, Mississippi 39205

MISSOURI
Missouri Water Pollution Board
P. O. Box 154
Jefferson City, Missouri 65101

MONTANA
Montana Water Pollution Council
State Department of Health
Laboratory Building
Helena, Montana 59601

NEBRASKA
Nebraska Water Pollution Control Council
State Department of Health
Box 94757, State House Station
Lincoln, Nebraska 68509

NEVADA
Bureau of Environmental Health
Dept. of Health, Welfare & Rehabilitation
Nye Building
201 South Fall Street
Carson City, Nevada 89701

NEW HAMPSHIRE
Water Supply and Pollution Control Commission
61 South Spring Street
Concord, New Hampshire 03301

NEW JERSEY
Div. of Air and Clean Water
State Department of Health
P. O. Box 1540
Trenton, New Jersey 08625

NEW MEXICO
New Mexico Water Quality Control Comm.
Department of Health & Social Service
P. O. Box 2348
Santa Fe, New Mexico 87501

NEW YORK
Division of Pure Waters
State Department of Health
84 Holland Avenue
Albany, New York 12208

NORTH CAROLINA
State Dept. of Water and Air Resources
P. O. Box 9392
Raleigh, North Carolina 27603

NORTH DAKOTA
Environmental Health & Engineering Services
State Department of Health
Bismarck, North Dakota 58501

OHIO
Water Pollution Control Board
State Department of Health
P. O. Box 118
Columbus, Ohio 43216

OKLAHOMA
Environmental Health Service
State Department of Health
3400 North Eastern
Oklahoma City, Oklahoma 73111

OREGON
Oregon State Sanitary Authority
P. O. Box 231
Portland, Oregon 97207

PENNSYLVANIA
Bureau of Sanitary Engineering
State Department of Health
P. O. Box 90
Harrisburg, Pennsylvania 17120

PUERTO RICO
Puerto Rico Dept. of Health
Ponce de Leon Avenue
San Juan, Puerto Rico 00908

RHODE ISLAND
Div. of Water Pollution Control
Rhode Island Dept. of Health
335 State Office Building
Providence, Rhode Island 02903

SOUTH CAROLINA
S. C. Water Pollution Control Authority
J. Marion Sims Building
Columbia, South Carolina 29201

SOUTH DAKOTA
Division of Sanitary Engineering
State Department of Health
Pierre, South Dakota 57501

TENNESSEE
Tenn. Stream Pollution Control Board
Cordell Hull Building
Sixth Avenue, North
Nashville, Tennessee 37219

TEXAS
Texas Water Quality Board
1108 Lavaca Street
Austin, Texas 78701

UTAH
State Water Pollution Control Committee
44 Medical Drive
Salt Lake City, Utah 84113

VERMONT
Vermont Department of Water Resources
State Office Building
Montpelier, Vermont 05602

VIRGINIA
State Water Control Board
P. O. Box 11143
Richmond, Virginia 23230

VIRGIN ISLANDS
Virgin Islands Dept. of Health
Charlotte Amalie
St. Thomas, Virgin Islands 00802

WASHINGTON
Washington Water Pollution Control Commission
P. O. Box 829
Olympia, Washington 98501

WEST VIRGINIA
Division of Water Resources
Department of Natural Resources
1201 Greenbrier St., East
Charleston, West Virginia 25311

WISCONSIN
Division of Environmental Protection
Department of Natural Resources
P.O. Box 450
Madison, Wisconsin 53701

WYOMING
Sanitary Engineering Services
State Dept. of Health & Social Services
State Office Building
Cheyenne, Wyoming 82001

Interstate Commissions

Bi-State Development Agency
Suite 619 Paul Brown Bldg.
St. Louis, Missouri 63101
Illinois
Missouri

Interstate Sanitation Commission
10 Columbus Circle
New York, New York 10019
Connecticut
New Jersey
New York

Hudson River Valley Commission
30 Rockefeller Plaza
New York, New York 10020
New York
New Jersey

Ohio River Valley Water Sanitation Commission
414 Walnut Street
Cincinnati, Ohio 45202
Illinois
Indiana
Kentucky
New York
Ohio
Pennsylvania
Virginia
West Virginia

Delaware River Basin Commission
25 Scotch Road, P.D. Box 360
Trenton, New Jersey 08603
Delaware
New Jersey
New York
Pennsylvania

Klamath River Compact Commission
P. D. Box 388
Sacramento, California 95802
California
Oregon

Tennessee River Basin Water Pollution Control Commission
Central Services Building
Nashville, Tennessee 37219
Kentucky
Mississippi
Tennessee

Interstate Commission on the Potomac River Basin
1025 Vermont Avenue, N.W.
Washington, D. C. 20006
District of Columbia
Maryland
Pennsylvania
Virginia
West Virginia

New England Interstate Water Pollution Control Commission
73 Tremont Street
Boston, Massachusetts 02108
Connecticut
Maine
Massachusetts
New Hampshire
New York
Rhode Island
Vermont

OFFICE OF PUBLIC INFORMATION
FEDERAL WATER QUALITY ADMINISTRATION
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C. 20242

Environmental Agencies

Atomic Accessories Div.
Baird Atomic, Inc.
33 University Rd.
Cambridge, Mass. 02138

Automotive Manufacturers Assoc., Inc.
320 New Center Bldg.
Detroit, Mich. 48202

Conservation Foundations
1250 Conn. Ave.
Washington, D.C.
(pesticides)

Lake Ontario Environmental Studies
Piez Hall
State University College
Oswego, N.Y. 138

National Industrial Pollution Control Council
Superintendent of Documents
U.S. Government Printing Off.
Washington, D.C. 20402

Wilderness Society
729 Fifteenth St. NW
Washington, D.C. 20005

Wildlife Management Institute
Publications Dept. Wire Bldg.
Washington, D.C. 20005

SELECTED READING IN EDUCATIONAL PERIODICALS

AMERICAN VOCATIONAL JOURNAL
May 1971
Four articles dealing with Environmental Education

MAN/SOCIETY/TECHNOLOGY
February 1971
The entire magazine is devoted to Environmental Education

SCHOOL SHOP
April 1971
Entire magazine is devoted to Environmental articles.

A BALANCED EDUCATION FOR A BALANCED ECOLOGY: WHAT IA CAN DO
School Shop
Levy, Gerald & Resnick, Harold S.
December 1971
pp. 20-21 & 39

BUILDING YOUR ENVIRONMENTAL POLLUTION LIBRARY
Industrial Arts & Vocational Education (Figurski, Arthur J.)
November 1971 pp. 48
A list of publications dealing with environmental information
pp. 48, 50, 52, 56, 57

GET A PART OF THE ENVIRONMENTAL ACTION
School Shop (Figurski, Arthur J.)
September 1972 p. 47

IS INDUSTRIAL ARTS RELEVANT WITHOUT TALKING ABOUT POLLUTION CONTROL?
Industrial Arts & Vocational Education, Smalley, Lee
October 1970
p. 38, 84, 85

TEACHING ABOUT POLLUTION ISN'T JUST HOT AIR
Industrial Arts & Vocational Education
Figurski, Arthur J.
October 1971
pp. 22, 23, 52, 54, 57

PERIODICALS

For the student to make the best use of up to date materials it is adviseable to get him into the library and reading current magazines with articles on Industrial Ecology. The student can use the Readers Guide to help him locate the articles he is interested in.

The list below indicates a wide range of topics found in current periodicals.

AIR POLLUTION

The Atomic Plant with a Fog Horn, Popular Science, Pioch, Ray, Dec. 1972, Pg. 60-61.

The Big Push To Atomic Breeder Reactors, Readers Digest, Maisel, Albert Q., April 1972, Pg. 164.

Catalytic Muffler, Readers Digest, Sept. 1972

Clean Power From Dirty Fuels, Sientific American, Squires, Authur M., October 1972

Coming Clean in Detroit; Designs That May Meet 1975-76 Standards, Newsweek, January 17, 1972, pp. 72-7?.

Drive in And Fill Up With Natural Gas, Businee World, April 8, 1972, Pg. 19.

Just How Safe Is A Nuclear Power Plant, Readers Digest, Miller, James N., June 1972, Pg. 5.

The Search For Tomorrow's Power, National Geographic, Weaver, Kenneth F. November 1972, Pg 650- 681.

SO_2 Control: Status, Cost And Outlook, Power Engineering, Spaite, Paul W., Oct. 1972, Pg. 34-37

Water Pollution

A) er Restored: Oregon's Williamette, National Geographic, Starbird, nel A., June 1972, Pg. 816-835.

From Congress Though New Rules For Clean Water, U.S. NEWS, October 30, 1972, Pg. 38

More Facts On Water Pollution, Successful Farming, April 1972, Pg. 40.

Ralph Nader Report; Water, Water Every Where But Hardly a Pure Drop To Drink, Ladies Home Journal, Nader, R., August 1972, Pg. ?8-?9.

(Water Pollution Con't)

Underway: Drive To Clean Up The Lakes, U.S. News, April 24, 1972, Pg. 52.

Solid Waste

Bottles, Cans, Energy, Returnables, Throwaways, And Recycling Environmental Magazine, Hannon, B.M., March, 1972, Pgs. 11-12.

An Ecological Can Crusher, Mechanix Illustrated, Dec. 1971, Pg. 56.

From Bottles To Bricks, Science Digest, March 1972, Pg. 66-68.

Recycling, Answer To Our Garbage Predicament?, Readers Digest, Schiller, R., March 1972.

Recycling Garbage, Time Magazine, April 3, 1972, Pg. 58.

What To Do With Waste? Use It Over And Over And Over Again, N.Y. Times Magazine, Cole, L.C., April 10, 1972, Pg. 30-31

Noise Pollution

How Scientific Is Stealing The Thunder Of those Noisy Jets, Popular Science, Dec. 1972, Pg. 72.

Noise: The Unseen Pollution, Scientific News, Gilluly, R.H., March 18, 1972, Pg. 189- 191.

Quiet, Please!, Environmental Protection Agency Report, News Week, Feb. 7, 1972, Pg. 45.

ENVIRONMENTAL PERIODICALS

DESIGN AND ENVIRONMENT
6400 Goldsboro Road
Washington, D.C. 20034
$11/year

ENVIRONMENTAL QUALITY BULLETIN
American Iron and Steel Institute
Public Relations Department
1000 16th St., N.W.
Washington, D.C. 20036

ENVIRONMENTAL SCIENCE & TECHNOLOGY
1155 16th Street, N.W.
Washington, D.C. 20036
$6.00/year

NATIONAL WILDLIFE
National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

RANGER RICK'S NATURE MAGAZINE
National Wildlife Federation
(same address as above)
$6.00/year

NEW YORK STATE ENVIRONMENT
58 Wolf Road
Albany, New York

POLLUTION ENGINEERING
1301 S. Grove Ave.
Barrington, Ill. 60010
$12/year

RODALE'S ENVIRONMENTAL ACTION BULLETIN
Rodale Press
Environmental Action Bulletin
Emmaus, Pa. 18049
Dept. EB-20
$10/year (52 weeks)

THE CONSERVATIONIST
New York State Department of Environmental Conservation
Albany, New York 12201
$2/year

TRADE JOURNALS

Trade journals carry articles on Environmental Problems and Solutions in each issue. These magazines proved to be very valuable to the student for project ideas and addresses of companies dealing with environmental problems.

AMERICAN WATER WORKS ASSOCIATION JOURNAL
American Water Works Assn., Inc.
2 Park Ave.
N.Y., N.Y. 10016
Subscription rates $20/year

AIR AND WATER NEWS
330 West 42nd Street
N.Y., N.Y. 10036
A weekly report on environmental control: the law, the markets, the technology, solid waste, recycling, land use, noise.
Send for free sample of weekly newsletter.

AUTOMOTIVE ENGINEER
T.K. Garrett Iliffe Transport
Publications Ltd.
Dorset House
Stamford St.
London, S.E.I. England
$12/year

TECHNOLOGY REVIEW
Technology Review
Room E19-430
Massachusetts Institute of Technology
Cambridge, Mass. 02139
$9/year

THE AMERICAN CITY MAGAZINE OF MUNICIPAL MANAGEMENT & ENGINEERING
Buttenheim Publishing Corporation
Berkshire Common
Pittsfield, Massachusetts 01201
Subscription rates: $15/year

WATER AND SEWAGE WORKS
434 S. Wabash
Chicago, Ill. 60605
Subscription rates: $7.50/year

BOOKLETS & PAMPHLETS

The following list of booklets and pamphlets are categorized according to:

A - Air Pollution
W - Water Pollution
S - Solid Waste
N - Noise
P - Pesticides

A, W, N 1. AIR POLLUTION
WATER POLLUTION
NOISE POLLUTION
ADDISON-WESLEY PUBLISHING COMPANY, INC.
MEHLO PARK, CALIFORNIA
OR
READING, MASS.

These three books are written on a junior high level and would be useful for background material.

S 2. ANSWER YOUR QUESTIONS ABOUT RECLAIMING
U.S. Department of the Interior
Bureau of Reclaiming
Allis L. Armstrong, Commissioner
Washington, D.C

A series of questions and answers about reclaiming

N 3. A PRIMER OF NOISE MEASUREMENT
General Radio Company
West Concord
Massachusetts

A 34 page booklet which provides basics about noise, hearing damage, and noise measurement.

A 4. A PROGRESS REPORT FROM GENERAL MOTORS ON AUTOMOTIVES AIR POLLUTION CONTROL
Technical Information Department
G.M. Research Laboratories
General Motors Technical Center
Warren, Michigan August 1971

A,W,S,P 5. CLEANING OUR ENVIRONMENT THE CHEMICAL BASIS FOR ACTION
American Chemical Society
Special Issue Sales
1155 Sixteenth St., N.W.
Washington, D.C. 20036

A 250 page report on air pollution water pollution, solid waste pollution and pesticides in the environment.

S 6. COORS ALUMINUM RECYCLING PROGRAM
Adolph Coors Public Relations Dept.
1321 Bannock Street
Denver, Colorado 80204
A packet which describes the Adolph Coors Company cash-for-cans program

A,W,S 7. ENVIRONMENTAL EDUCATION MARCH 1971
Regents of the University of the State of New York Education Department
Albany, New York
A statement of the policy and proposed action on environmental education

A,W,S 8. FRONTIER MAGAZINE
Winter 1971
ITT Research Institute
10 West 35th Street
Chicago, Illinois 60616
Technical and economically sound solutions to the problems of pollution.

S 9. GLASS CONTAINERS
National Industrial Pollution Control Council
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
Describes what the glass container manufacturers are doing to reuse and reclaim glass.

A,W,S,N 10. IMPROVE YOUR ENVIRONMENT - FIGHT POLLUTION WITH PICTURES
Kodak Consumer Market Division
Rochester, New York 13650
$1.00
A booklet consisting of pictures which describe different problems dealing with pollution and how to take pictures with impact.

A,W,S 11. POLLUTION (Some questions and answers)
Dofasco-Dominion Foundaries and Steel, Ltd.
P.O. Box 460
Hamilton, Ontario Canada
A booklet dealing with the areas of pollution and what pollutants are. Also brief description of what Dofasco is doing about pollution.

A,W,S,N, P 12. NATIONAL WILDLIFE FEDERATION 1971 E.Q. INDEX
National Wildlife Federation
1412 16th St. N.W.
Washington, D.C. 20036
Pamphlet telling and showing environmental trends in all areas.

A,W 13. KEEP IT CLEAN
Bethlehem Steel Corporation
Bethlehem, Pennsylvania 18016
A publication that highlights Bethlehem Steel's Pollution Control Program

S 14. PURCHASING RECYCLED PAPER
A Prospectus by the Council of New York Law Associates
The Council of New York Law Associates
Room 510
36 West 44th Street
New York, New York 10036
The pamphlet contains environmental benefits of paper recycling present users of recycled paper and the information on the availability and cost of recycled paper.

S 15. RECYCLING AND ENVIRONMENTAL IMPROVEMENT PAPERS... ARE THEY HERE TO STAY
Bergstrom Paper Company
Heenah, Wisconsin 54956
A pamphlet on recycling paper.

S 16. RECYCLING OF TIN FREE STEEL CANS, TIN CANS AND SCRAP FROM MUNICIPAL INCINERATOR RESIDUE
by E.J. Ostrowski
Division Chief
Process Metallurgy Research
National Steel Corp
Recycling of tin tree cans from residue and the products they later become. Graphs and charts included.

A 17. 1972 REPORT ON PROGRESS IN AREAS OF PUBLIC CONCERN
GM Technical Center, Warren, Michigan February 1972

A 18. STEEL HORIZONS
Allegheny Ludlum Steel Corp.
Oliver Building
Pittsburg, Pennsylvania 15222

A,W 19. THE ONE-LEAF BOOK STORY OF ENVIRONMENT & INDUSTRY
American Iron and Steel
Institute
1000 16th Street N.W.
Washington, D.C. 20036

S 20. THE SOLID WASTE FACT BOOK
Glass Container Manufacturer's Institute, Inc.
330 Madison Ave.
New York, N.Y. 10017
A booklet dealing with solid waste, disposal methods and dangers of solid wastes.

S 21. THE STORY OF GLASS CONTAINERS
Glass Container Manufacturers
Institute Incorporated
330 Madison Avenue
New York, New York 10017

S 22. THE LITTER FACT BOOK
Glass Containers Manufacturer's Institute, Inc.
330 Madison Ave.
New York, N.Y. 10017

A,W 23. TOWARD A BETTER ENVIRONMENT
E.I DuPont De Nenoru and Co., Inc.
Wilmington, Del. 19898
A colorful pamphlet which describes how DuPont is helping to control their emissions.

A 24. YOUR CAR AND CLEAN AIR
Automobile Manufacturers Association
320 New Center Bldg.
Detroit, Michigan 48202
A good pamphlet describing the auto maker's role in controlling pollution.

FILM AND FILMSTRIP RESOURCES

The following list of film and filmstrips are catagorized according to the following areas; AIR, WATER AND SOLID WASTE, with a broad grouping of GENERAL INTEREST. With the quick reference listing by subject, films and filmstrips can rapidly be found. A list of film and filmstrip distributors can be found at the end of the listing.

AIR POLLUTION

1. AIR POLLUTION AND CARS
   A laymar s look at the causes of smog and what is being done to reduce it.
   G. M. 16 min. COLOR/SOUND

2. AIR POLLUTION : EVERONE'S PROBLEM
   A review of air pollution and how we contribute to it.
   N. Y. S. D. E. C. COLOR/SOUND

3. AIR POLLUTION IN PERSPECTIVE
   A study of the automobile's related to air pollution and automobile controls.
   G. M. 35 min. COLOR/SOUND

4. THE ANSWER IS CLEAR
   Air pollution ....particulary as seen and explained by a bus driver.
   G. M. 14 min. COLOR/SOUND

5. ELEVEN TOGETHER: A SEARCH FOR CLEAN AIR
   Pollution controls and devices being used on modern automobiles.
   Ford Motor Co. 26 min. COLOR/SOUND

6. FIRST MILE UP
   Problems of air pollution and its effects on human health.
   McGraw-Hill 28min B/W

7. THE POISONED AIR
   Carousel 60 min B/W

8. PROGRESS OF POWER
   A spectrum of full-scale running vehicles to evaluate automotive air pollution control devices and possible power source replacement
   G. M. 16 min. COLOR/SOUND

9. WORK IN PROGRESS ; STEEL AND THE ENVIRONMENT
A look at what the steel industry is doing to control their air pollution
American Iron and Steel Institute 28 min COLOR/SOUND

WATER POLLUTION

1. BEARGRASS CREEK
The tragedy of a small tributary stream, its promising start , and its sad end due to pollution.
Stuart Finley 19 min COLOR/SOUND

2. CLEAN WATER
Emphasises the importance of clean water as a natural resource.
N. Y. S. D. E. C. 27 min COLOR/SOUND

3. CRISIS ON THE KANAWHA
Causes of water pollution are discussed and methods of prevention and treatment.
N. Y. S. D. E. C. 22 min COLOR /SOUND

4. CRISIS ON OUR RIVERS
Pollution of streams is shown and that water pollution is everone's problem.
N. Y. S. D. E. C.

5. OOPS !
Shows industrial pollution from a plant and the results of and guards against such pollution.
N. Y. S. D. E. C. 20 min COLOR/SOUND

6. THE PROBLEM WITH WATER IS PEOPLE
Film relates the causes of the Colorado River's pollution and the spread of pollution. A look at the future.
NBC News 30 min COLOR/SOUND

7. WATER POLLUTION
Shows health problem posed by water pollution and steps taken to eliminate them.
Encyclopedia Britannica 15 min COLOR

SOLID WASTE POLLUTION

1. 5000 DUMPS
   How communities are solving the practical problems of closing dumps and beginning sanitary landfills.
   E.P.A. 21 minutes

2. THE GARBAGE EXPLOSION
   The present problems of solid waste disposal and possible solutions.
   Encyclopedia Britannica 18 minutes

3. THE GREAT ALL-AMERICAN TRASH CAN
   Recycling of waste materials made into useful products.
   Glass Container Corp. 13 min. Color/Sound

4. THE REALITIES OF RECYCLING
   Shows equipment being used to recover refuse materials from solid wastes.
   E.P.A. 38 minutes Color/Sound

5. THE THIRD POLLUTION
   Review of solid waste management and means now being used to dispose of solid wastes.
   N.Y.S.D.E.C. or Stuart-Finley Color/Sound

GENERAL INTEREST

1. MAN AND HIS RESOURCES
   28 min. B/W

2. THE GIFT
   Review of America's natural resources and the legacy of clean air, water and virgin land, now threatened by pollution.
   Modern Talking Pictures

3. NINE MILE POINT
   Environmental studies before the building of Niagara Mohawk's nuclear power station.
   Niagara Mohawk 23 min. Color/Sound

FILMSTRIPS

1. ENVIRONMENTAL DECISIONS: AN INQUIRY
   The science of life, man's impact on his environment. Web of life.
   Wards Color

2. ENVIRONMENTAL POLLUTION: OUR WORLD IN CRISIS
   A series of six (6) filmstrips to acquaint the student with environmental pollution problems of the air, water and land.
   Wards Color

FILM AND FILMSTRIP SUPPLIERS' ADDRESSES

1. American Iron and Steel Institute
   1000 16th Street, N.W.
   Washington, D.C. 20036

2. Carousel Films, Inc.
   1501 Broadway
   New York, New York 10036

3. Commonwealth Film Dist.
   1440 S. State College Blvd.
   Bldg. K-6
   Anaheim, California 92806

4. Conservation Foundation
   1250 Connecticut Avenue N.W.
   Washington, D.C. 20036'

5. Contemporary Films/McGraw-Hill
   327 W. 41st St.
   New York, New York 10036

6. Encyclopedia Britannica
   Educational Corporation
   425 N. Michigan Ave.
   Chicago, Ill. 60611

7. (E.P.A.)
   Environmental Protection Agency
   National Medical Audiovisual Center (annex)
   Station K
   Att. Film Order Desk
   Atlanta, Ga.

8. Extension Media Center
   University of California
   Berkeley, Calif. 94720

9. Ford Motor Company
   The American Road
   Dearborn, Michigan 48121

10. General Motors Film Library
    General Motors Bldg.
    Detroit, Michigan 48202

11. Graw-Hill
    Film Rental Offices
    330 W. 42nd St.
    New York, New York 10036

12. Modern Talking Pictures Service Library
    2323 New Hyde Park Road
    New Hyde Park, New York 11040

13. National Wildlife Federation
    1412 16th St., N.W.
    Washington, D.C. 20036

14. (N.Y.S.D.E.C.)
    New York State Department of Environmental Conservation
    Conservation Education
    Albany, New York 12201
    Att. Film Loan Library

15. Niagara Mohawk Power Corp.
    (Contact local branch office for further information and details about films and speakers.)

16. Stuart Finley Productions
    3428 Mansfield Rd.
    Falls Church, Va. 22041

SELECTED ENVIRONMENTAL BOOKS

Adams, Donald F. AIR POLLUTION INSTRUMENTATION. Pittsburgh, Instrument Society of America, 1966

Besselievra, Edmund B. INDUSTRIAL WASTE TREATMENT. McGraw-Hill 1952

Bloom, Sandra and Degler, Stanley. PESTICIDE AND POLLUTION. B.N.A. 1969. paper

Camp, Thomas R. WATER AND IMPURITIES. New York, Reinhold 1963

Carlson, Carl. WATER FIT TO USE. John Day, 1966

Cowman, Edward. OIL AND WATER: THE TORREY CANYON DISASTER. Lippincott, 1968

Faith, W.L. AIR POLLUTION CONTROL. Wiley, 1959

Goldman, Marshall. CONTROLLING POLLUTION, THE ECONOMICS OF A CLEANER AMERICA. Prentice-Hall, 1967

Goodman, G.T., ed. ECOLOGY AND THE INDUSTRIAL SOCIETY. Wiley, 1965

Grava, Sigurd. URBAN PLANNING: ASPECTS OF WATER POLLUTION. Columbia, 1969.

Hawkes, Herbert A. ECOLOGY OF WASTE WATER TREATMENT. MacMillan, 1963

Iowa Water Resources Pollution Control and Abate Seminar. WATER POLLUTION CONTROL AND ABATEMENT. Iowa State Univ. 1967

Johnson, Huey D., ed. NO DEPOSIT- NO RETURN. Addison- Wesley, 1970

Kneese, Allen V. MANAGING WATER QUALITY. John Hopkins, 1968

Krenkel, Peter and Frank Parker, eds. BIOLOGICAL ASPECTS OF THERMAL POLLUTION. Vanderbilt Univ. Press, 1969

Kneese, Allen V. MANAGING WATER QUALITY. Johns Hopkins, 1968

Lewis, Alfred. CLEAN THE AIR! FIGHT SMOKE, SMOG AND HAZE ACROSS THE COUNTRY. McGraw-Hill, 1966

Mellanby, Keith. PESTICIDES AND POLLUTION. W. Collins.

National Acadamy of Science, RESOURCES AND MAN. Freeman, 1970. paper.

Navarra, John G. OUR NOISY WORLD. Doubleday, 1969.

Nordell, Eshel. WASTE TREATMENT FOR INDUSTRIAL AND OTHER USES. VanNostrand-Reinhold, 1961.

Odum, Eugene P. ECOLOGY. Rev. ed. Holt, Reinehart & Winston, 1969

Riley, Charles M. OUR MINERAL RESOURCES: AN ELEMENTARY TEXBOOK IN ECONOMIC GEOLOGY. Wily, 1969.

Ross, R.D., ed. INDUSTRIAL WASTE DISPOSAL. Reinhold, 1968

Wilson, B. R. ENVIRONMENTAL PROBLEMS: PESTICIDES, THERMAL POLLUTION, AND ENVIRONMENTAL SYNERGISMS. Lippincott, 1968

Yerges, L. F. SOUND, NOISE AND VIBRATION CONTROL. VanNostrand, 1969

AIDS AND DEVICES

To help the instructor implement the program these aids could be used from Day One to make the student more aware of the Environmental Problems and possible solutions.

CAREER EDUCATION IN THE ENVIRONMENT
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

A useful handbook designed to be used in secondary schools to explore environmental problems and solutions and to provide information on existing and emerging career opportunities in the environmental field.

CATALOG OF FREE TEACHING MATERIALS
by Salisbury, Gordon
P.O. Box 1075
Ventura, California 93001
Price - $2.50 - 15¢ for mailing charges

Free teaching materials found in all areas.

CONSERVATION AND FULL UTILIZATION OF WATER
U.S. Government Printing Office
Washington, D.C. 20402
10¢ a colorful chart

Showing how water develops and is used in the environment.

CONSERVATION KIT
American Petroleum Institute
School Program
1271 Avenue of the Americas
New York, N.Y. 10020
Free Pictures and discussion kit, 1970

ECOLOGY POSTER CARDS
Milton Bradley
Springfield, Massachusetts
$3.00

THE GLASS PACKAGING STORY
Glass Container Manufacturers Institute Inc.
330 Madison Avenue
New York, New York 10017

A package containing glass samples and uses.

HOW MAN POLLUTES HIS WORLD
National Geographic Society
Washington, D.C. 20036
$2.00
A large colored poster showing all the ways man pollutes the environment. 42-1/2" by 29-1/2"

POSTERS ON POLLUTION
Argus Communications
3505 North Ashland Avenue
Chicago, Illinois 60657

SOLID WASTE RECYCLING
Plant/Hydrasposal/Fibreclaim Plant
Black Clawson
Hydrasposal/Fibreclaim
Franklin, Ohio
Chart showing the method of solid waste disposal.

SECTION 8

GLOSSARY OF ENVIRONMENTAL TERMS

A SELECTED ENVIRONMENTAL GLOSSARY

ABSORPTION: Process by which one substance is dissolved by and distributed throughout the body of a second material, as a soluble gas, such as ammonia, is collected in water droplets.

ACCELERATOR: In nuclear physics, a device for speeding up charged subatomic particles to high enough energies to smash the nuclei of target atoms. Often called an atom-smasher. Accelerators are used routinely to produce radioisotopes.

ACTIVATED CARBON: A highly adsorbent form of carbon, used to collect many gaseous pollutants. Used both for measurement and control.

ACTIVATED WATER: A transient, chemically very reactive state created in water by absorbed ionizing radiation. Water used as a coolant in a nuclear reactor becomes so activated.

ADSORBENT: In addition to the adjectival meaning, the term describes any of several substances that collect gaseous pollutants. Used both for measurement and control.

ADSORPTION: Process by which gases or vapors are collected on the surface of a solid phase, by reason of the attraction between that surface and the absorbed material. Collection of organic vapors on activated charcoal is an example.

AERATION: Creating intimate contact between air and a liquid by: spraying the liquid in the air; bubling air through the liquid, or by agitation of the liquid to promote surface absorption of air.

AEROSOL: Particle of solid or liquid matter that can remain suspended in the air because of its small size. Particulates under 1 micron in diameter are generally called aerosols.

AFTERBURNER: A device that includes an auxiliary fuel burner and combustion chamber to get rid of combustible air contaminants.

AIR: So-called pure air is a mixture of gases containing about 78% nitrogen; 21% oxygen; less than 1% of carbon dioxide, argon, and other inert gases; and varying amounts of water vapor.

AIR CONTAMINANT: Any "foreign" material in the air, that is, material other than oxygen, nitrogen, the noble gases, water vapor, and carbon dioxide. Air contaminants include, but are not limited to the following examples:

AIR MONITORING: The continuous sampling for and measuring of pollutants present in the atmosphere.

AIR POLLUTION: Man-made contamination of the atmosphere, beyond that which is natural and excluding the narrowly occupational, as the contaminated air that miners or asbestos workers breathe.

AIR QUALITY CONTROL REGION: As the federal government uses the term, an area where two or more communities--either in the same or different states--share a common air pollution problem. Designated by the Secretary of Health, Education, and Welfare, these regions are required to set and enforce consistent air quality standards.

AIR QUALITY CRITERIA: As the federal government uses the term, the varying amounts of pollution and lengths of exposure at which specific adverse effects to health and welfare take place.

AIR QUALITY STANDARD: As the federal government uses the term, the prescribed level of a pollutant in the outside air that cannot legally be exceeded during a specified time in a specified geographical area.

AIRSHED: A term, now little used, denoting a geographical area the whole of which, because of topography, meteorology, and climate, shares the same air. See atmospheric area.

AIRWAY RESISTANCE: The narrowing of the air passages of the respiratory system in response to the presence of irritating substances.

AMBIENT AIR QUALITY: Definition of the outdoor atmosphere as it exists around people, plants and structures--as contrasted to that in immediate proximity to emission sources.

AMBIENT AIR QUALITY CRITERIA: A scientific relationship between particular concentrations and durations of specific air contaminants, and the effects they produce on persons, animals, plants or materials. "Criteria" in this sense has a connotation distinct from "standard." Although the dictionary lists the two as synonymous, care must be exercised not to confuse them in any consideration of air pollution control.

AMBIENT AIR QUALITY STANDARDS: Legal statements of ambient air quality that are subject to enforcement by law. Standard may specify maximum peak concentration of contaminant allowable, maximum average concentration and/or frequency and duration of excursions above a given concentration. Criteria inform what effects can be avoided through adoption of a given standard.

ANODE: A positive electrode.

ASSIMILATIVE CAPACITY: Capacity of a water body to receive, dilute, and carry away wastes without harming water quality. In the case of organic matter, also includes the capacity for natural biological oxidation, which may be expressed in pounds of BOD per day at a specific river flow rate and temperature.

ATMOSPHERE: Outdoor air; more specifically, the troposphere.

ATMOSPHERIC AREA: As the federal government uses the term, a segment of the continental United States in which climate meterology, and topography--all of which influence the capacity of the air to dilute and disperse pollutants--are essentially similar.

ATTRITION: Wearing or grinding down by friction. One of the 3 basic contributing processes of air pollution, the others being vaporization and combustion.

BETA RAY: A stream of negatively charged electrons ejected from the nucleus of an atom; more penetrating than an alpha ray but producing less ionization. Often written B-ray.

BIOCHEMICAL OXYGEN DEMAND (BOD): Quantity of oxygen used in the biological oxidation of organic matter, in a specified time and at a specified temperature, determined by its availability to serve as food for the microorganisms. BOD can be related to the oxygen resources of a stream. For example, after dilution and mixing in a stream, one part of BOD will consume one part of oxygen in the stream.

BIOLOGICAL OXIDATION: Process by which bacteria and other microorganisms feed on complex organic materials and decompose them. Self-purification of waterways, as well as activated sludge and trickling filter waste treatment processes, depend on this principle. It is also called Biochemical Oxidation.

BIOSPHERE: All living things together with their environment.

BLOOM: A visible concentrated growth of algae and/or other aquatic plants.

CARBON MONOXIDE: A colorless, odorless, very toxic gas produced by any process that involves the incomplete combustion of carbon-containing substances. One of the major air pollutants, it is primarily emitted through the exhaust of gasoline-powered vehicles.

CARBURETOR: A device for supplying certain internal-combustion engines with a mixture of vaporized fuel and air.

CATHODE: A negative electrode.

CATALYSIS: The facilitation of a chemical reaction induced by a material--called the catalyst--that remains unchanged in the process.

CENTRIFUGAL COLLECTOR: Any of several mechanical systems using centrifugal force to remove aerosols from a gas stream.

CHEMICAL ENERGY: The energy contained in the chemical bond between atoms; it can be released into the environment by a chemical reaction; e.g., combustion.

CHEMICAL OXYGEN DEMAND (COD): Laboratory measurement of the amount of oxygen consumed under specific conditions in the oxidation of organic material by a strong chemical oxidant which decomposes both biodegradable (measured by Biochemical Oxygen Demand) and non-biodegradable organic matter.

CLARIFIER: A tank or other vessel to accomplish removal of settleable solids; e.g., as in an activated sludge process. Settling basin serves similar purposes.

COH: Abbreviation for coefficient of haze, unit of measurement of visibility interference.

COMBUSTION: The production of heat and light energy through a chemical process -- usually oxidation. One of the 3 basic contributing processes of air pollution, the others being attrition and vaporization.

COMMUNITY AIR: The outside air shared by a community, rather than the perhaps particularly polluted air in the immediate vicinity of a factory.

CONDUCTION: The transfer of heat by physical contact between substances.

CONTAMINATION: The impairment of water quality to the extent that a health hazard is created.

CONVECTION: The transfer of heat through a liquid or gas by the actual movement of the molecules.

CYCLONE COLLECTOR: A kind of centrifugal collector.

DEGRADABLE WASTES: Substances which are changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural waters.

DIESEL ENGINE: A type of internal-combustion engine that uses a fuel injector and produces combustion temperatures by compression.

DISSOLVED OXYGEN (DO): Extent to which oxygen occurs dissolved in water or wastewater. It is usually expressed as concentration, in parts per million, or per cent of saturation.

DISTILLATION: The removal of impurities from liquids by heating the liquids to the boiling point and then condensing the vapors.

DUST: Solid particles small enough to become airborne, formed by attrition of larger particles.

ECOLOGY: The totality or pattern of the interrelationship of organisms and their environment, and the science that is concerned with that interrelationship.

ECONOMIC POISONS: Those chemicals used as insecticides, rodenticides, fungicides, herbicides, nematocides (a nematode is a class of parasitic worm), or defoliants.

ECOSPHERE: The layer of earth and troposphere inhabited by or suitable for the existence of living organisms.

EFFLUENT: In this context refers to a flow of wastewater to its receptor; the wastewater may or may not have been subjected to waste treatment, and the receptor may be a river, municipal sewer, or the like.

EFFLUENT STANDARDS: Defined limits of waste discharge, e.g., in terms of volume, content of contaminants, temperature, and the like.

EUTROPHICATION: Over-enrichment of a quiescent water body by water nutrients, tending to produce excessive plant growth. Commonly associated with accelerated "aging" of lakes, namely progressive change in the indigenous plant and animal life supported therein.

FILTER COLLECTOR: A mechanical filtration system for removing particulate matter from a gas stream, for measurement, analysis, or control. Also called bag collector. Filters are designed in a variety of sizes and materials for specific purposes.

FLARE: A fire produced by a pilot flame at a stack outlet, used in many heat treating operations and petroleum industry processes to burn combustible waste gases.

FLUORIDES: Gaseous or solid compounds containing flourine, emitted into the air from a number of industrial processes; fluorides are a major cause of vegetation and--indirectly--livestock damage.

FLY ASH: The particulate impurities resulting from the burning of coal and other material, which are exhausted into the air from stacks.

FOG: The condensation of water vapor in the air. Also see smog.

FOSSIL FUELS: Coal, oil, and natural gas; so-called because they are the remains of ancient plant and animal life.

FUEL CELL: A device for converting chemical energy into electrical energy.

FUME: Solid particles under 1 micron in diameter, formed as vapors condense or as chemical reactions take place.

FURNACE: A combustion chamber; an enclosed structure in which heat is produced.

GASES: Materials that can be condensed to liquids only by pressure, or at temperatures below ambient (such as oxygen, methane, hydrogen).

GENERATOR: A device that changes mechanical energy into electrical energy.

ELECTRODE: A conductor used to establish electrical contact with a non-metallic part of a circuit, such as an electrolyte. There are two electrodes in such a circuit, the anode, with a positive charge, and the cathode, with a negative one. See electrolysis.

ELECTROLYSIS: The production of chemical changes by means of an electric current passing through an electrolyte.

ELECTROLYTE: A non-metallic substance which will conduct an electric current by the movement of ions when dissolved in certain solvents or when fused by heat; common salt is an example.

ELECTROMAGNETIC WAVES: Waves of radiant energy, commonly classified, according to wave frequency and length, as Hertzian (radio) infrared, visible (light), ultraviolet, X-ray, and gamma ray; and, by extension, particle emissions, such as alpha and beta radiation, or rays of mixed or unknown type, as cosmic radiation.

ELECTROSTATIC PRECIPITATOR: A device which collects particulate matter by passing the air stream through a strong electric field and negatively charging the suspended particles which are then drawn to a positive collecting electrode. Precipitator can remove 99.9 percent of all particulates.

EMISSION INVENTORY: A list of primary air pollutants emitted into a given community's atmosphere, in amounts (commonly tons) per day, by type of source. The emission inventory is basic to the establishment of emission standards. Also see emission factor.

EMISSION STANDARDS: Legally enforceable limits on the quantities and/or kinds of air contaminants that may be emitted into the atmosphere. For example: Limits expressed in maximum concentration of contaminant in the discharged gases; maximum weight of such discharge, either as an hourly rate or in relation to the quantity of material being processed; or in terms of the appearance of the discharge.

ENVIRONMENT: The aggregate of all the external conditions and influences affecting the life, development, and ultimately the survival of an organism.

EPIDEMIOLOGY: The study of diseases as they affect populations rather than individuals, including the distribution and incidence of a disease; mortality and morbidity rates; and the relationship of climate, age, sex, race, and other factors.

GREENHOUSE EFFECT: The phenomenon in which the sun's energy, in the form of light waves, passes through the air and is absorbed by the earth, which then reradiates the energy as heat waves that the air is able to absorb. The air thus behaves like glass in a greenhouse, allowing the passage of light but not of heat.

HALF-LIFE: The period of time required for 1/2 of the atoms of a given radioactive substance to decay.

HEAT EXCHANGER: A device for transferring heat energy in a nuclear reactor without contaminating the final energy carrying substance with radioactivity.

HEAT ISLAND EFFECT: The phenomenon of air circulation peculiar to cities, in which warm air builds up in the center, rises, spreads out over the town, and as it cools, sinks at the edges; while cooler air from the outskirts flows in toward the city center to repeat the flow-pattern. In this way, a self-contained circulation system is put in motion that cen be broken only by relatively strong winds.

HYDROCARBON: Any of a vast family of compounds containing carbon and hydrogen in various combinations; found especially in fossil fuels. Some of the hydrocarbon carbons are major air pollutants: they may be carcinogenic or active participants in the photochemical process.

INCINERATION: The burning of household or industrial waste.

INERT GAS: Also called noble or rare gas; one that does not react with other substances under ordinary conditions.

INERTIAL SEPARATORS: Air pollution control equipment that uses the principle of inertia to remove particulate matter from a stream of air or gas.

INVERSION: The phenomenon of a layer of cool air trapped by a layer of warmer air above it so that the bottom layer cannot rise. A special problem in polluted areas because the contaminating substances cannot be dispersed.

LAGOON: Scientifically constructed pond in which sunlight and oxygen support the action of microorganisms in decomposing organic wastes by biological oxidation.

LOW FLOW AUGMENTATION: Controlled discharge of water from an inpoundment or reservoir for dilution of waste during periods of low stream flow.

MECHANICAL TURBULENCE: The erratic movement of air influenced by local obstructions.

MIST: Liquid particles up to 100 microns in diameter.

MIXING DEPTH: The expanse in which air rises from the earth and mixes with the air above it until it meets air equal or warmer in temperature.

NITROGEN OXIDES: Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; e.g., in internal-combustion engines; considered major air pollutants.

NUCLEAR ENERGY: The force released by nuclear decay; radioactivity.

ORGANIC: Of, relating to, or derived from living organisms; in chemistry, a carbon-containing compound.

OXIDANT: The capacity of certain oxygen-containing substances to react chemically in the air to form new substances. Also any of the substances that make oxygen available for such a chemical reaction.

OXIDES OF NITROGEN: Compounds formed by the fixation of nitrogen at high temperatures, as in furnaces and internal combustion engines. Primary product is nitric oxide (NO), which slowly oxidizes in air, but much more rapidly in the presence of sunlight and organic vapors, to nitrogen dioxide (NO_2). Other nitrogen oxides may have brief existence as intermediates in the atmospheric reactions involved.

OXIDES OF SULFUR: Products of the oxidation of sulfur; they include both sulfur dioxide (SO_2) and sulfur trioxide (SO_3), and the acids formed by their combination with water. Of these, sulfuric acid (H_2SO_4), is of principal interest.

OZONE: A form of oxygen (O_3) produced in the reactions of photochemical smog and in electrical discharges. A powerful oxidizing agent and toxic to both plants and animals at relatively low concentrations.

PAN: Peroxyacetylnitrate--one of the family of peroxyaclynitrates--reactive compounds formed in photochemical smog, highly toxic to many species of plants, and to which, at least in part, the eye-irritating properties of photochemical smog have been ascribed.

PHOTOCHEMICAL PROCESS: The chemical changes brought about by the radiant energy of the sun acting upon various polluting substances. The products are known as photochemical smog.

PPM: Parts per million; the number of parts of a given pollutant in a million parts of air.

PRECIPITATORS: Any of a number of devices using mechanical, electrical, or chemical means to collect particulates. Used for measurement, analysis, or control.

PRIMARY TREATMENT: First stage of waste treatment, usually by sedimentation, removing a high percentage of suspended matter but little or no colloidal or dissolved matter.

RINGELMANN CHART: Actually a series of charts, numbered from 0 to 5, that simulate various smoke densites, by presenting different percentages of black. A Ringelmann No. 1 is equivalent to 20 per cent black; a Ringelmann No. 5, to 100%. They are used for measuring the opacity of smoke arising from stacks and other sources, by matching with the actual effluent the various numbers, or densities, indicated by the charts. Ringelmann numbers are sometimes used in setting emission standards.

SCRUBBER: A device that uses a liquid spray to remove aerosol and gaseous pollutants from an air stream. The gases are removed either by absorption or chemical reaction. Solid and liquid particulates are removed through contact with the spray. Scrubbers are used for both the measurement and control of pollution.

SECONDARY TREATMENT: Second stage of waste treatment, usually connoting treatment by biological oxidation.

SEDIMENT: Soil and mineral solids of small particle size conveyed in water.

SELF-PURIFICATION: The process by which a stream becomes pure after being polluted. This occurs by oxygen-using bacteria decomposing organic matter which may enter a stream, and by hhe natural replenishment of oxygen from the atmosphere.

SETTLEABLE SOLIDS: Suspended solids which will settle out in a reasonable period of quiescence. Such period is commonly, though arbitrarily, taken as two hours. Also called settling solids.

SMOG: The irritating haze resulting from the sun's effect on certain pollutants in the air, notably those from automobile exhaust; see photochemical process. Also a mixture of fog and smoke.

SMOKE: Solid and/or liquid particles formed by the incomplete combustion of fuels, and discharged suspended in the gaseous combustion products.

SOOT: Solid particles containing carbon formed by the incomplete combustion of carbonaceous fuels.

SORPTION: A term including both adsorption and absorption. Sorption is basic to many processes used to measure, analyze, and remove both gaseous and particulate pollutants.

STACK: A smokestack; a vertical pipe or flue designed to exhaust gases and any particulate matter suspended therein.

SULPHUR OXIDES: Pungent, colorless gases formed primarily by the combustion of fossil fuels; considered major air pollutants; sulfur oxides may damage the respiratory tract as well as vegetation.

SUSPENDED SOLIDS: Solids that either float on the surface or remain suspended in liquids; removable by filtering.

VAPOR: Gaseous material which results from dilution with fixed gases, but which, if pure, would occur as a solid or liquid at the ambient temperature (such as water vapor).

VAPORIZATION: The change of a substance from the liquid to the gaseous state. One of the 3 basic contributing processes of air pollution, the others being attrition and combustion.

WATER POLLUTION: Presence of one or more contaminants in such degree as to be detrimental to the intended use of the water.

WATER QUALITY CRITERIA: Scientific data relating the concentration of one or more substances in water to the effects produced therefrom.

WATER QUALITY STANDARDS: Usually refers to permissible limits of certain water contaminants as defined in laws or regulations, compliance with which is required. Normally established on the basis of the quality requirements for selected beneficial water uses.